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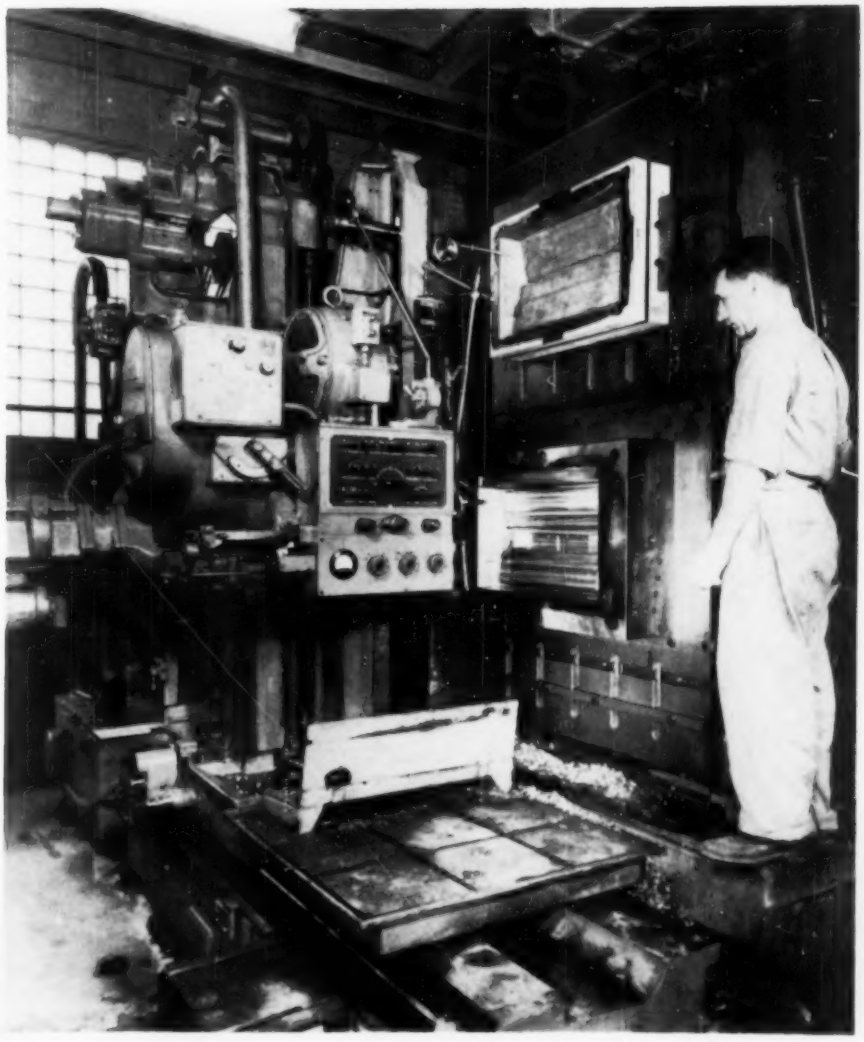

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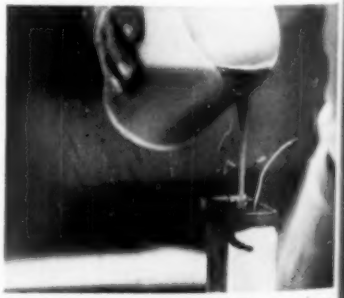
(Epon resins are the epoxy polymers manufactured exclusively by Shell Chemical Corporation.)

Miniature electronic components potted in Epon resin by Freed Transformer Company, Brooklyn, New York.

Section of magnetic amplifier coils embedded in Epon resin by Westinghouse Electric Corporation, Pittsburgh, Pennsylvania.



Potting transformer with Epon resin at PCA Electronics, Inc., Santa Monica, California.

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SPE JOURNAL

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Plastics lend a new dimension of beauty to one of the world's oldest games of skill. In the de luxe "Royal" brand mah jongg set just introduced by the A & L Manufacturing Co., 9 Florence St., Brooklyn, N. Y., the traditional ivory titles have been replaced by Marblette cast phenolic tiles in a dusty rose color. The racks are also of Marblette in five mottled jewel-tone shades—yellow, blue, green, red, and purple. The dice and counters are of the same plastic material, while the chips used as money in the game are of molded styrene.

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Book Reviews . . . .

CHEMICAL ENGINEERING MATERIALS

Frank Rumford, 382 pages, Chemical Publishing Company, Inc., New York, 1955:—$7.50

This is the first American edition of a text book written for chemical engineers. The properties of all materials are fully described and emphasis is given to resistance to corrosion. The mechanism of corrosion is described in the first chapter which is followed with studies of various metals and their alloys.

The second part of the book deals with coatings, cements, concrete, bricks, tiles and insulating compounds, silicones, glass and wood. The last chapter is devoted to plastics and rubber and gives, in a condensed form, a great deal of information on the tensile strength, thermal conductivity, comparative strength, thermal expansion, resistance to alkalies and other physical and chemical properties of the various types of plastics. More data are found in three appendices including the correlation of British standards and ASTM specifications.

The book contains 170 illustrations, 40 tables and hundreds of references. It is easy to read and as much as plastics are often used in combination with metals, plastics engineers will find it useful.

Dr. Louis C. Barail

INDUSTRIAL CHEMISTRY, ORGANIC,

by Martin and Cooke. Published by Philosophical Library 15 East 40th St., New York 16, N.Y., 1955. 752 pages 6" x 9½". Price $17.50.

The scope and purpose of this book are well stated in the Preface, ". . . a treatise on the applications of organic chemistry to the arts and manufactures. It embraces both British and American practice . . ." The book actually provides a good practical survey of most of the chemical industry, and is, as one of the authors suggests, of main interest to an executive or chemist wanting to know about fields other than his own. The book is excellent for this purpose, and it would also be a valuable addition to a technical or reference library.

A number of chapters will be of interest to polymer chemists other than the one on the plastics industry, as can be seen from the topic headings listed below. The chapter on the plastics industry gives a good, brief survey, but will contain no news to anyone actually in plastics.

While many chapters have been completely rewritten, and most other brought up to date, some of the data on exports and imports is only for the years 1900 and 1910.

Sections of the book deal with the following industries: I. Oil, Fat, Varnish and Soap. II. Sugar. III. Starch. IV. Cellulose. V. Fermentation. VI. Charcoal and Wood-Distilling. VII. Turpentine and Rosin. VIII. Industrial Gums and Resins. IX. Rubber. X. Aliphatic Chemicals. XI. Fuel Gas. XII. Coal-Tar. XIII. Synthetic Coloring Matters. XIV. Natural Dyestuffs. XV. Ink. XVI. Paint and Pigment. XVII. Textile Fiber, Bleaching and Water-Proofing. XVIII. Dyeing and Color Printing. XIX. Leather and Tanning. XX. Glue, Gelatine and Albumen. XXI. Synthetic and Other Drugs. XXII. Plastics. XXIII. Photographic Chemicals. XXIV. Tobacco.

Jesse H. Day

See Story on
MEMBERSHIP—page 41

Plastics Progress Presents . . .

SPE's Twelfth Conference

"Plastics Progress Presents" — The Twelfth Annual SPE Technical Conference at the Hotel Statler in Cleveland, January 18th through the 20th, 1956. This will be the largest technical meeting ever held in the plastics field. Approximately 75 papers by qualified speakers will be presented on all phases of the plastic industry. The papers will be presented in three simultaneous sessions. The subjects covered include injection and compression molding, a symposium on epoxy resins, properties of plastics, thermoplastic sheet, extrusion, calendering and coating, reinforced plastics, plastic foams, a plastic pipe symposium, a materials development symposium, and a design symposium. Speaker's Chairman, William E. Manring, has obtained the services of qualified speakers in each of these fields so there is something to interest everyone in the industry.

"Plastics Progress Presents" — A complete ladies program including morning coffee hours, luncheons, a stage play, a radio broadcast, style show, and a trip through Nela Park Home Lighting Center.

"Plastics Progress Presents" — A number of "firsts" for SPE Conferences, starting with an informal smoker Tuesday evening, so early arrivals can get together. Another first is the introduction of late afternoon "Bull Sessions" to bring together people of mutual interest for informal discussions. Another "first" which promises to be a highlight of the Conference is a closed-circuit telecast from duPont's new Polychemicals Department Sales Service Laboratories at Wilmington. With two-way communication the audience in Cleveland will be able to ask questions about the laboratory and get answers on the telecast. The most important "firsts" is the presentation to each registrant with a volume of the papers presented at the Conference.

"Plastics Progress Presents" — Also a lighter side to relieve the intensity of the technical sessions. Starting Tuesday evening with the smoker, continuing Wednesday noon with the luncheon and telecast, the entertainment reaches its climax Thursday evening with the cocktail party and banquet. The banquet speaker, Tennyson Guyer, is Director of Public Relations for the Cooper Tire & Rubber Company. Mr. Guyer is one of the most interesting and entertaining speakers on the after-dinner circuit today.

The Conference Committee, under the leadership of Frank A. Martin, General Chairman, has spared no effort to make this the biggest and best Technical Conference in the history of the industry. To insure its success the support of every SPE Member, and of the industry is solicited.

(Please turn to page 30)

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Extrusion Problems To be covered by New SPE Journal Feature column

A monthly column on the technology of extrusion will make its initial appearance in the December issue. Its function will be to bring readers practical, up-to-date information on virtually all aspects of this important subject.

Entitled "SPEaking of Extrusion," the column will be edited by Robert D. Sackett of the JOURNAL's editorial advisory committee. Each month some phase of extrusion will be discussed by Sackett or some other extrusion specialist. Some of the articles already planned will cover the role of the compression ratio, the importance of stock temperature in sheet extrusion, the practicality of adiabatic extrusion, and European extrusion practices.

Sackett, who is technical service associate for Monsanto Chemical Company's Plastics Division, has been active in the plastics industry for ten years. He is experienced in production, research and technical service.

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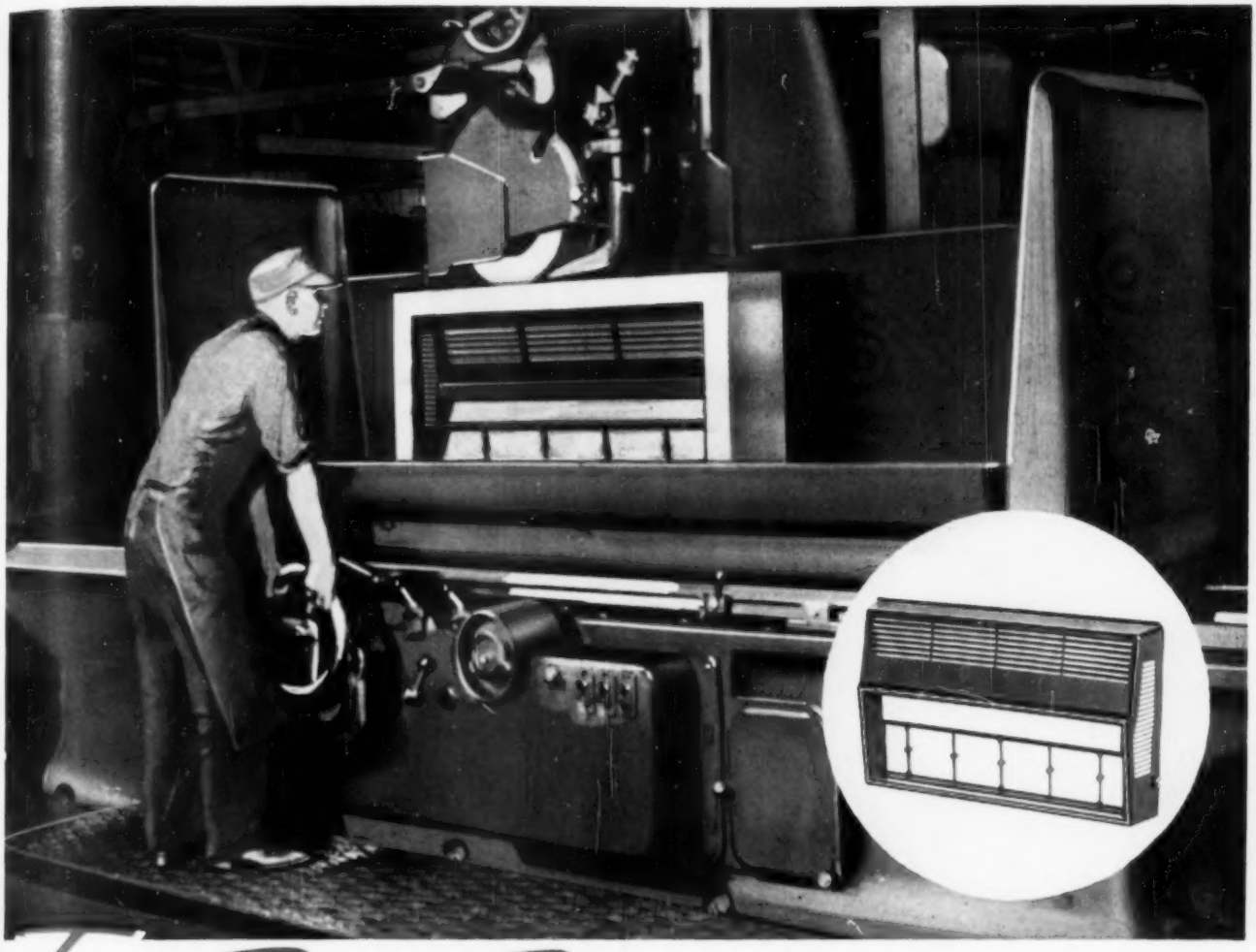

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Lustrex Hi-Test 88—Rubber-modified, high-impact styrene with fast flow and good gloss widely used for large industrial parts.
Lustrex LHA—modified medium impact material with high gloss.
Lustrex Hi-Heat 99—for applications requiring heat resistance up to 204° F.
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MONSANTO PROMOTION

New "Trip to Disneyland" Contest is typical of many Monsanto-inspired promotions for housewares, toys, wall tile, packaging and ...om molded parts. The sticker and official entry blanks pictured in this page are being furnished free to companies molding toys of Orizon and Lustrex.

MERCHANDISING

3,000,000 toys will be packaged with contest stickers and entry blanks this Christmas!

Five first prizes offering free trips to Disneyland and 1,010 additional awards—will provide a powerful extra incentive for families coast to coast to buy toys molded of Monsanto's Orizon polyethylene and Lustrex styrene.

Advertising in Dell Comic Books and over the CBS-TV network are part of Monsanto's plan for making this the biggest year in history for plastic toys.

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Buffalo	Ranson D. Thilk	76	15
Central Indiana	C. R. Smith	46	15
Central Ohio	William Croll	50	15
Chicago	E. E. Eckenbeck	354	71
Cleveland-Akron	Granville H. Shirley	219	45
Connecticut	Lewis Pentland	102	21
Detroit	John Slater	201	40
Eastern New England	Joseph Clancy	163	35
Golden Gate	James Smith	42	10
Kansas City	Jerome Kivett	52	15
Kentuckiana	J. Feller	4	—
Miami Valley	R. Wright	99	21
Milwaukee	Charles E. Egan	42	10
Newark	Frank L. Quimby, Jr.	428	85
New York	Arthur S. Jacobs	443	92
Northern Indiana	Phil Leonard	23	10
Northwest Pennsylvania	D. A. Leet	86	20
Ontario	C. Rea	122	21
Pacific Northwest	Don LeGassey	32	10
Philadelphia		230	47
Pittsburgh		61	15
Quebec	J. Bonnett	52	10
Rhode Island & S.E. Mass.	Sidney Lohman	107	22
Rochester	Albert F. Patterson	83	20
St. Louis	Chris Kacalieff	73	15
Southeastern Ohio	Paul M. Smith	43	10
Southern California	R. Griffith	138	28
Southern Section	R. W. Kruse	60	15
South Texas	T. Robb	41	10
Toledo	W. R. Anderson	66	15
Upper Midwest	Mrs. L. Bolstad	69	15
	W. G. Clark	202	40
Western New England	Orville Hultgren		
Worcester-Leominster		—	—
Non Section		58	—
TOTAL		3951	

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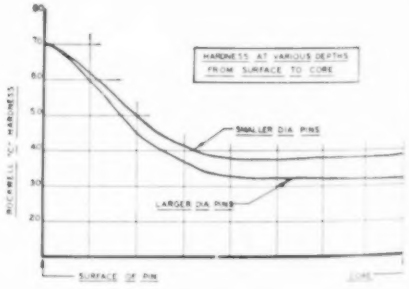

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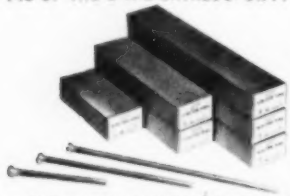

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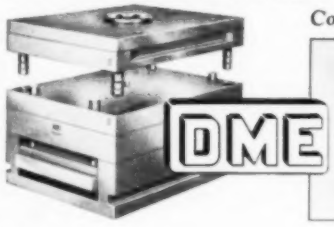

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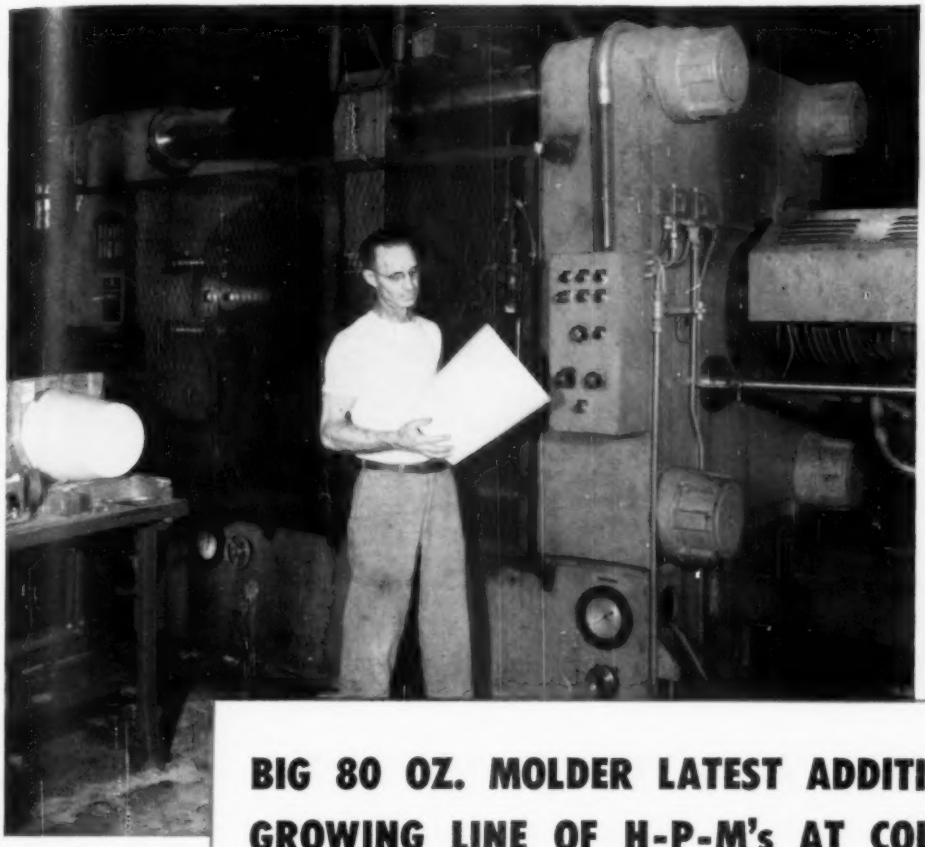

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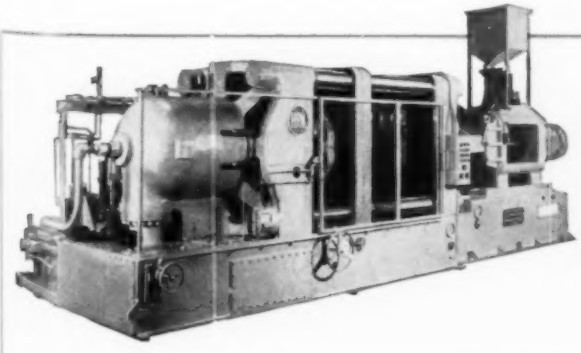

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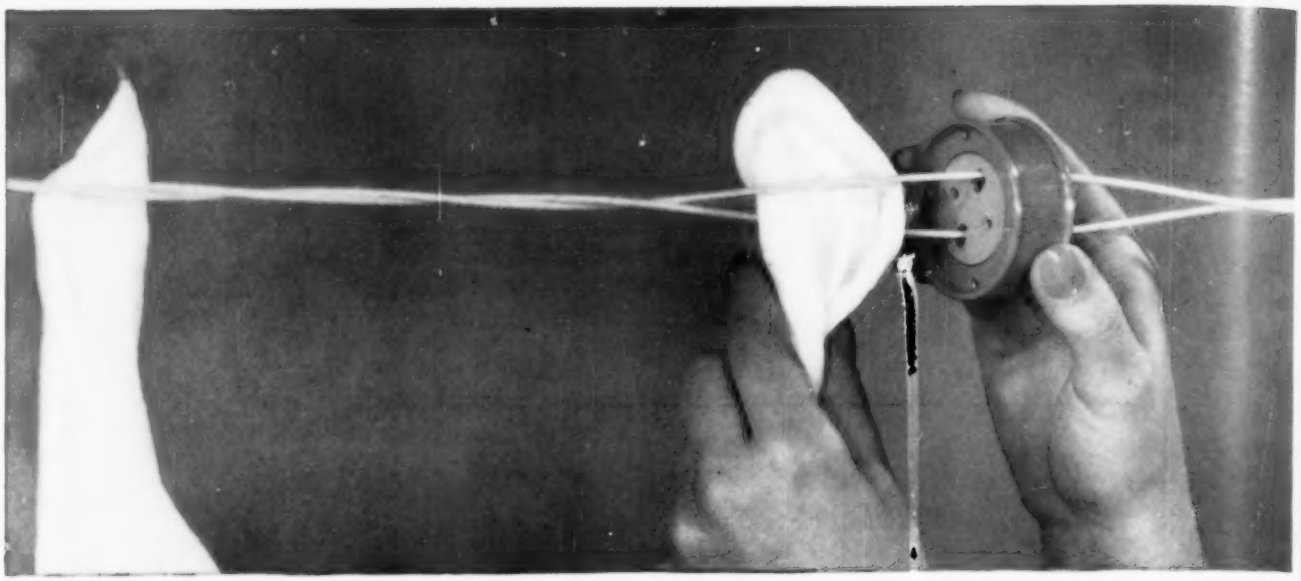
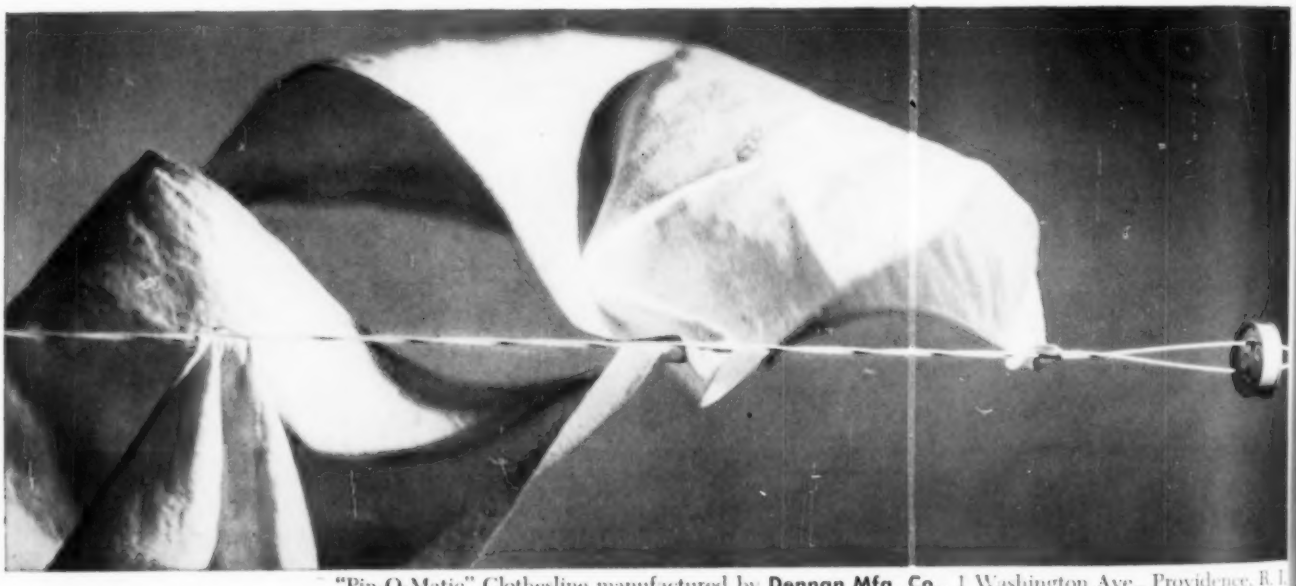


New twist for washday!



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The Functions of the Society of Plastics Engineers

Frank W. Reinhart
President of the SPE

Chief, Organic Plastics Division
National Bureau of Standards

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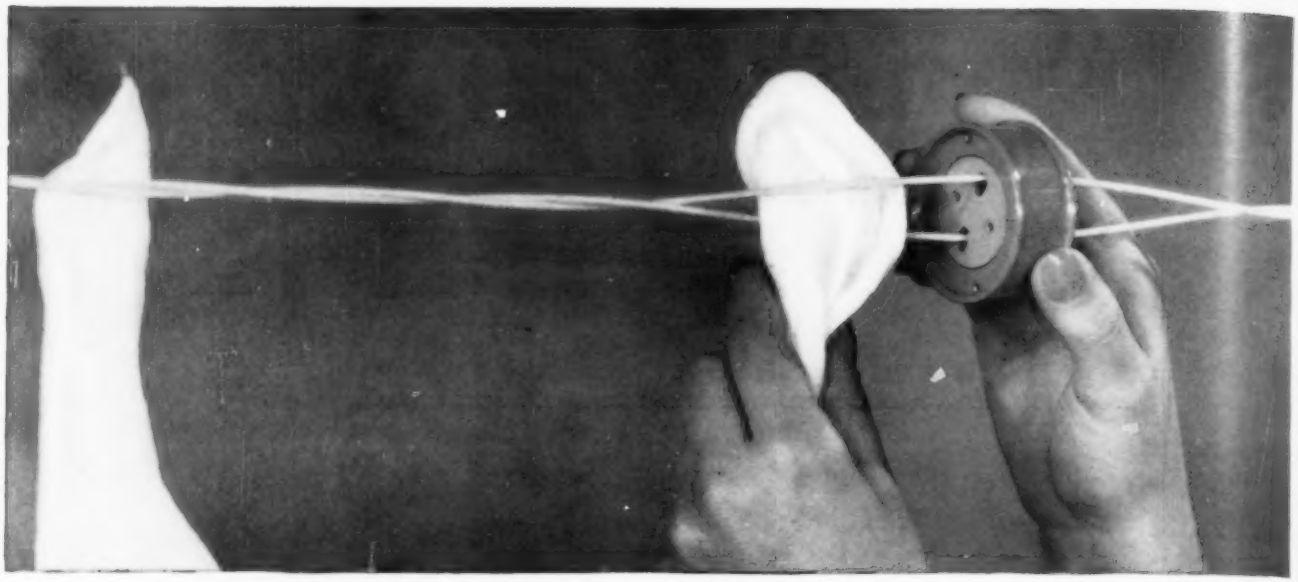

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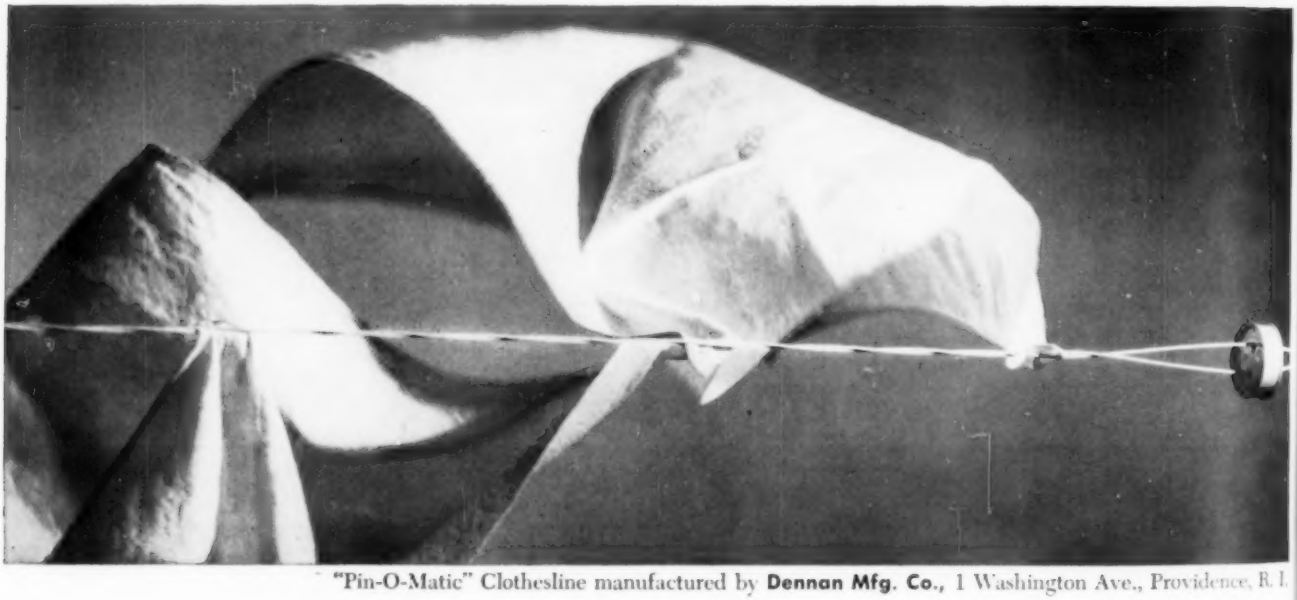

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Action— By Your National Organization

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The Functions of the Society of Plastics Engineers

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(Please turn to page 14)

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TEMPERATURE CONTROL UNITS

The Functions of SPE . . .

(Continued from page 13)

of the International Standards Organization. Official representation on other ASTM committees and other society groups concerned with plastics engineering is being investigated.

A new SPE Plastics in Building Committee has been organized with 30 members. It is the objective of this group to do all in its power to use and help others apply our knowledge of plastics engineering properly in building applications of all types.

"E" stands for Education

The successful continuation and growth of all scientific and engineering fields requires that new members be recruited and trained for work in that field. They are needed to replace those who drop out and for expansion. The training of these recruits is a primary function of those working in the field. The members of SPE are the only ones who know what they should be taught and how they should be trained. In addition the members have the "know-how" to do the job.

Several sections of the SPE are active in planning, furnishing facilities, and assisting in the teaching of skilled workers at a trade school level. The National Education Committee has been particularly active in organizing curricula at a university level for training plastics engineers. It is assisting several schools in establishing these curricula. To help define its goal, this committee has prepared a definition of a plastics engineer that has been accepted by unanimous vote of the Executive Committee and National Council.

A Plastics Engineer is an engineer mainly concerned with the application of principles of engineering to the production or utilization of plastics materials. An engineer is a person educated in the principles of mathematics and the physical sciences who applies this knowledge for the use and control of the materials and forces of nature for the safe and economical use and convenience of man.[1] A plastic is a material that contains as an essential ingredient an organic substance of large molecular weight, is solid in its finished state, and, at some stage in its manufacture or in its processing into finished articles, can be shaped by flow.[2]

Another phase of the education activities is the registration of plastics engineers. This problem is particularly difficult for two reasons. First, many states register only "engineers" and not particular types. Second, the examinations are usually based on phases of engineering with which materials engineers are not concerned and consequently in which they have little training and no experience. This problem is being tackled from several angles.

Expansions of our functions are needed and would be worthwhile. However, this will require additional funds and time of members. These are expected to be forthcoming in the near future.

Suggestions regarding detailed expansion of our functions will be welcomed by the National Officers and the National Council.

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[1] *Kansas Engineering Registration Law (1931).* A. L. McCawley, "*Professional Engineering Registration Laws*," Trustee Foundation Fund, Jefferson City, Missouri, 1952.
[2] *American Society for Testing Materials "Tentative Definitions of Terms Relating to Plastics." ASTM Designation: D883-55T.*

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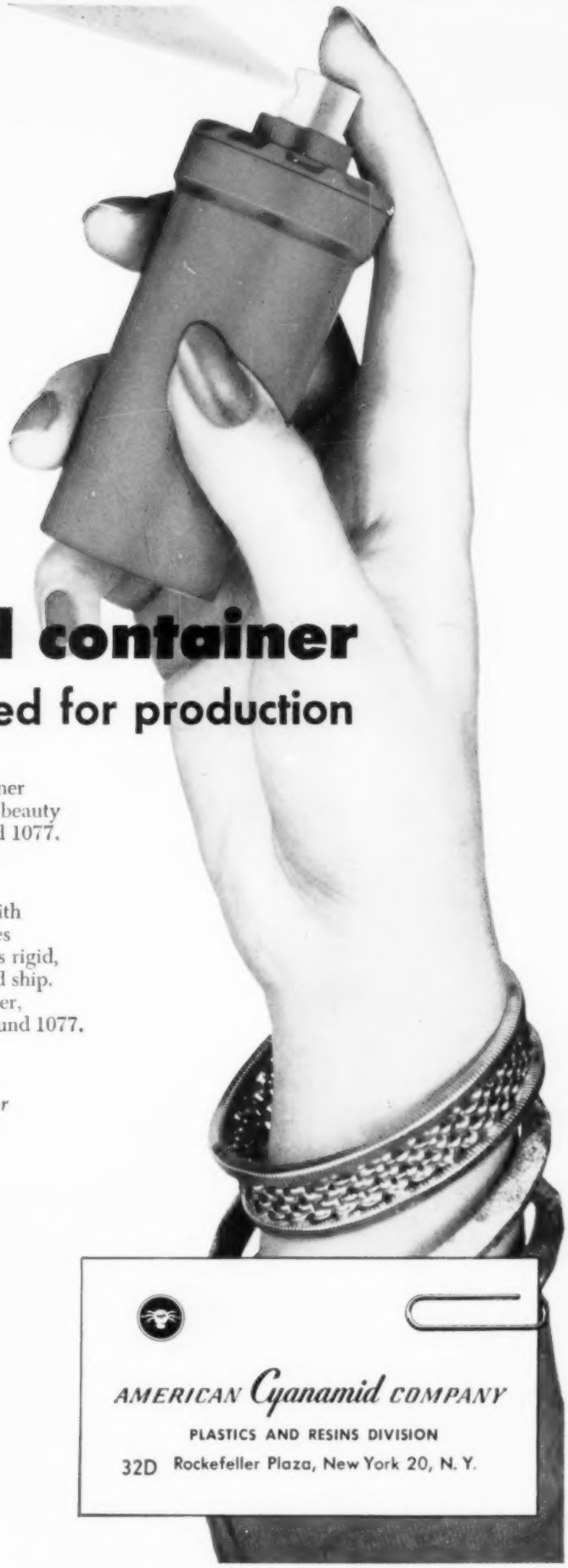

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For further information contact S. A. McElroy, Hercules Powder Company, 865 Union Commerce Building, Cleveland, Ohio.

The Physical Properties of "Teflon" Polytetrafluoroethylene

R. C. Doban, C. A. Sperati, and B. W. Sandt
E. I. du Pont de Nemours & Company, Inc.

"TEFLON"* TETRAFLUOROETHYLENE RESIN is one of the most remarkable high polymers created by chemical synthesis in that it has a combination of useful chemical and physical properties which cannot be found in any other single material of construction, natural or man made.

This high polymer of tetrafluoroethylene is produced by the du Pont Company as a granular polymer for general use in compression molding, as an aqueous dispersion for coating metals and fabrics, and as an extrusion powder for use with an extrusion aid (Table I). (1)

TABLE I
Grades of "Teflon" Tetrafluoroethylene Resin

GRADE	DESCRIPTION	USE
"Teflon"—1	30 mesh granular powder	General purpose compression molding
"Teflon"—5	60 mesh granular powder	Special purpose compression molding. Electrical tape.
"Teflon"—30	Aqueous dispersion 60% solids	Coating fabrics, metals.
"Teflon"—6	Extrusion powder	For use with an extrusion aid.

"Teflon" is outstanding in its extreme inertness to chemical attack, unusually high thermal stability, low dielectric loss and high dielectric strength, unique nonadhesion and low frictional properties, and in its striking retention of properties over an extraordinarily wide range of temperature. These remarkably diverse properties will be described one by one and numbers will be put on them to show, in a quantitative way, how good it really is. There has in the past sometimes been an aura of mystery associated with the properties and use of fluorocarbons although there is really nothing at all mysterious about this remarkable plastic. We will try to dispel any mystery by explaining why it has the properties that it does and why it is and should be different from any other plastic. We are going to do this by relating its properties to its chemical structure.

Most of the unique properties in "Teflon" are a consequence of its true fluorocarbon structure. By true fluorocarbon we mean that there are only two chemical elements, carbon and fluorine in Teflon. With the exception of condensation polymers, such as the polyamides and the polyesters, almost all synthetic resins have a skeleton framework of carbon atoms onto which other elements or chemical groups are attached. For example, in polyethylene, a true hydrocarbon polymer, hydrogen atoms are attached to the skeleton carbon chain and in polyvinyl chloride, a halogenated hydrocarbon, hydrogen and chlorine atoms are affixed to the chain. The unique properties of "Teflon" derive from the fact that fluorine atoms alone are attached to the carbon skeleton.

Fluorine, the Most Reactive Element

Fluorine is the most reactive chemical element known. (2) Once it has reacted, however, it forms chemical compounds of unusual stability. The carbon-fluorine bond in fluorocarbons is in fact one of the strongest bonds known among organic compounds. (3) The carbon-carbon bond which forms the backbone of the polymer chain is also one of the strongest single bonds capable of forming high polymer molecules. Many of the remarkable properties of fluorocarbons are related to the strength of these primary chemical bonds.

A second attribute of fluorine which contributes to the uniqueness of these polymers is its effective size. Above is a photograph of a polytetrafluoroethylene chain segment constructed from approximately scaled atomic models. The black pyramids represent the carbon atoms of the skeleton and the lighter hemispheres the fluorine atoms. It can be seen from this model that the fluorine atoms are the correct size to form a tight cover over the carbon skeleton. If the substituents were smaller there would be large gaps in the cover and if they were much larger they would crowd each other and would not be able to form a smooth, regular sheath. This sheath of fluorine atoms serves as an impenetrable shield that protects the carbon chain from attacking reagents. Other molecules simply cannot penetrate this protective shield. X-ray diffraction studies have suggested that the carbon chain is twisted about its own axis to give the distinctive spiral character so evident in this photograph. (4)

Secondary Valence Forces Important

In order to explain several properties of "Teflon," it is necessary to introduce a basic and important concept of polymer physics; namely, the matter of secondary valence forces. These are the forces that operate between polymer chains. They are only about one-tenth as strong as are the primary valence bonds holding the atoms together in a molecule, but they are, nevertheless, very important, for they determine to a large extent the physical properties of high polymers.

As the various chemical and physical properties are discussed, an understanding of these properties will be greatly facilitated if the several attributes of true fluoro-

**Du Pont registered trade-mark.*

carbons which have just been mentioned are kept in mind; namely, that the primary bonds between the atoms in the polymer chain are very strong, that the secondary valence forces between adjacent chains are weak and that the symmetrical arrangement of fluorine atoms forms a smooth impenetrable sheath protecting the carbon chain skeleton. With this theoretical background in mind, let us consider the various chemical and physical properties.

"Teflon" is extremely resistant to attack by the most highly corrosive chemicals. Materials such as aqua regia, hydrofluoric acid, fuming sulfuric acid, chlorosulfonic acid, hot fuming nitric acid, boiling solutions of sodium hydroxide, gaseous chlorine, hydrogen peroxide, and organic materials such as esters, ketones, alcohols, acid chlorides, and highly halogenated organic substances have no effect on the polymer. (5) Only molten alkali metals, such as sodium or potassium, and chlorine trifluoride and gaseous fluorine at elevated temperature and pressure will attack "Teflon" chemically. There is no solvent known that will swell or dissolve the polymer at temperatures below 300°C (570°F). Some highly fluorinated lubricating oils, however, will swell "Teflon" at temperatures above its 327°C (620°F) crystalline melting point. This amazing chemical inertness is maintained even at elevated temperatures. The data in Table II compare the change in tensile strength of both "Teflon" and polychlorotrifluoroethylene, the only other high temperature plastic that approaches that chemical inertness of "Teflon," after immersion at elevated temperature in various solvents representing many types of chemical compounds. The decrease in tensile strength is a measure of the extent of degradation or plasticization suffered by the polymer. These data indicate clearly that it is completely unaffected by any of the solvents listed. This remarkable chemical resistance has led to wide use of "Teflon" as an anti-corrosive material of construction in the chemical process industries for objects such as gaskets, tubing, pump and valve parts, packings, seals and diaphragms.

The almost universal chemical inertness of "Teflon" is related to the three attributes of fluorocarbons that were discussed previously. First, fluorine atoms are so tightly bound to the carbon chain with very strong primary chemical bonds that attacking reagents cannot pull them off. This leaves the protective fluorine sheath intact to function as a shield for the more vulnerable carbon skeleton. It will be recalled from the chain model (Figure 1) that the fluorine atoms cover the carbon chain so completely that it is quite impossible for other reagents to get close enough to attack the carbon skeleton. Finally, the insolubility is a consequence of the very weak attraction of fluorocarbons for other molecules. Substances will dissolve if there is a strong interaction between the secondary valence forces of the solvent molecules and those of the material to be dissolved. If the intermolecular forces are such that there is little interaction, the solubility will be low. Thermodynamic considerations have also led to the prediction that low molecular weight fluorocarbons would have a lower solubility in organic media than any other organic substances normally liquid at room temperature. (6) Solubility, moreover, is a property which decreases continuously with increasing molecular weight and high polymers in general are at the low end of any solubility relationship. It is not surprising that the low unit solubility of fluorocarbons when taken over the long polytetrafluoroethylene chain gives a molecule that is completely insoluble below its melting point.

If a fluorine atom in the repeat unit of a polytetrafluoroethylene molecule is replaced by some other atom, a point of chemical weakness is introduced. Since other elements form weaker bonds with a carbon atom than does fluorine, the replacement of fluorine with another atom gives an attacking reagent a point where the protective sheath can be penetrated. Once the sheath is broken, the carbon chain is exposed to attack. Furthermore, if the symmetry of the molecule is broken up, the secondary valence forces are altered in a way such that the molecule becomes more easily soluble.

Low Coefficient of Friction

Another unusual property of "Teflon" is the extremely low coefficient of friction. Under certain test conditions, coefficients of friction as low as 0.02 have been measured. (7) This value is independent of the temperature up

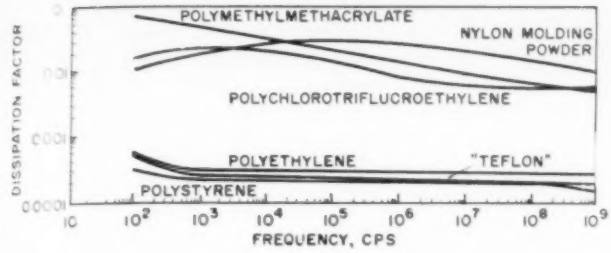
TABLE II

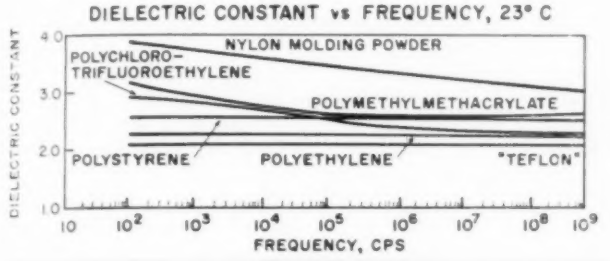
Chemical Resistance of Fluorine-Containing Polymers at Elevated Temperature, 24-Hour Exposure

Reagent	Class	Temp.		Tensile Strength, psi* and % Change After Exposure	
		°C	°F	"Teflon"	Polychlorotrifluoroethylene
None		23	73	3200 ± 200	5400 ± 300
Piperidine	Organic base	106	222	0%	Decomposed
Acetophenone	Aromatic ketone	150	302	0%	Plasticized and melted
Dioxane	Cyclic ether	101	214	0%	—35%
Tetrahydrofuran	Cyclic ether	66	151	0%	—43%
Ethyl acetate	Ester	77	170	0%	—33%
Carbon tetrachloride	Halogenated hydrocarbon	77	170	0%	—24%
Ethylene bromide	Halogenated hydrocarbon	100	212	0%	0%
Aniline	Aromatic base	150	302	0%	—63%
Toluene	Aromatic hydrocarbon	100	212	0%	—42%
Concentrated sodium hydroxide	Strong inorganic base	100	212	0%	0%
Benzene + aluminum chloride	Organic reaction medium	95	203	0%	—41%
Steam		150	302	0%	0%

**Specimens were totally immersed in the various reagents at the temperatures noted for 24 hours, dried overnight at room temperature and tensile properties measured at 23° C at a crosshead speed of 5 inches per minute.*

Figure 2





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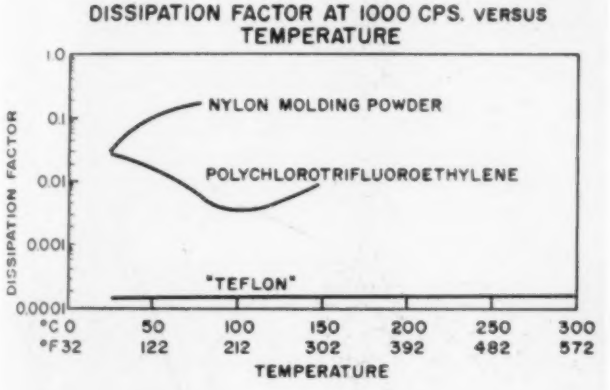
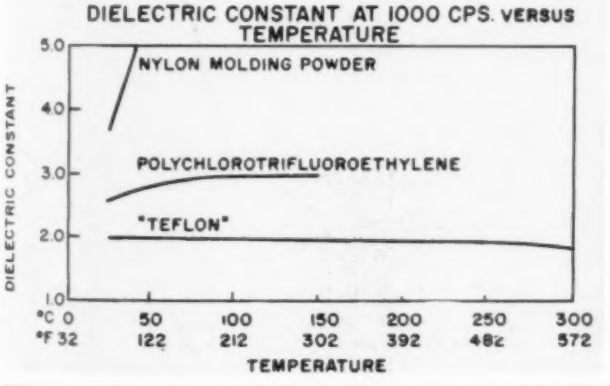




to the crystalline melting point (327°C, 620°F) and appears to be independent of the load, provided that surface melting does not occur. The static coefficient for "Teflon" is equal to the dynamic value and hence it does not exhibit a stick-slip type of motion. The low coefficient of friction has opened up a new and potentially large field of application for "Teflon" in mechanical parts, primarily bearing surfaces. The use of "Teflon" as a bearing in pumps is an excellent example of the combination of properties offered by "Teflon". In this instance, the chemical inertness of "Teflon" plus its unusually low frictional properties have made possible a bearing whose surface cannot be matched by those made of any other material.

A unique property related to the low friction characteristics is the fact that few materials tend to stick to its surface. This unique nonadhesive property of "Teflon" is utilized in a variety of operations in which sticky materials are handled. By covering the critical surfaces of processing equipment with "Teflon", great improvements in ease of operation can often be achieved. On bread-sheeting rolls "Teflon" eliminates the need for accurately ground scrapers, otherwise needed to strip the sticky dough from the sheeting rolls. It reduces or eliminates the use of dusting flour to reduce sticking and makes it possible to produce bread of improved quality because a thinner sheet is rolled. The use of "Teflon" on heat-sealer plates of wrapping machines eliminates sticking of packaging materials to the sealer plates and prevents build-up of foreign matter on the plates.

These nonadhesive and low friction properties of "Teflon" arise from the nature of the secondary intermolecular forces in fluorocarbons. These forces are such that other substances are not attracted with any appreciable strength. (8) Disturbing the symmetry of the fluorine sheath by substituting other atoms dissipates the nonadhesive and low friction properties. Work at the Naval Research Laboratory has shown that as the hydrogen atoms in a polyethylene-type structure are replaced with fluorine the coefficient of friction goes down, whereas replacement with chlorine leads to an increase in the coefficient of friction. (9)

Its excellent electrical properties have found many uses for "Teflon" in the electrical industries—uses where a high dielectric strength and low dielectric loss are required. Spacers and inserts for coaxial cables, insulation for high temperature and high frequency wires, and high-quality wrapping tape for insulating motors, generators and conductors have been fabricated from "Teflon".

Dissipation Factor Is Low

The dissipation factor and dielectric constant are very low, $1 \pm 1 \times 10^{-4}$ and 2.0, respectively. They are virtually independent of frequency over the range of 60 to 10^9 cycles-per-second (Figure 2). (10) These properties are, furthermore, only very slightly altered at elevated temp-

TABLE III

Electrical Properties of "Teflon"

Property	Units	Method	
Dielectric constant, 23°C, 60 to 10^9 cps		Ref. 10	2.0
Dielectric strength, short-time, 0.080 in.	v/mil	D149-44	400-500 (1)
Dissipation factor, 23°C, 60 to 10^9 cps		Ref. 10	$1 \pm 1 \times 10^{-4}$
Surface arc-resistance	sec.	D495-42	>700 (2)
Volume resistivity, dry, 23°C	ohm-cm	Ref. 10	10^{19}
Volume resistivity, 100% R.H.	ohm-cm	D257-52T	$>10^{15}$
Surface resistivity, 100% R.H.	megohms	D257-52T	3.6×10^6

Tests have been performed by A.S.T.M. methods unless otherwise indicated. Data shown are average values and should not be used for specifications.

(1) Value is 1000-2000 volts/mil in thickness of 5 to 12 mils.

(2) Does not track.

eratures (Figure 3). Over a frequency range of 10^2 to 10^5 cycles-per-second, the dissipation factor does not change within the limits of the experimental method at temperatures as high as 314°C. (11) The dielectric constant over the same frequency range, however, decreases slightly from 2.00 at 23°C to 1.81 at 314°C. (11) The volume resistivity is 10^{19} ohm-cm at 23°C. (10) and is greater than 10^{15} ohm-cm even after prolonged soaking in water. The surface resistivity is 3.6×10^{12} ohms even at 100 per cent relative humidity. "Teflon" also has great arc resistance. On exposure to an arc, regardless of time of exposure, the material leaves no carbonized conducting path since any material that is affected goes to a nonconducting gas. Short time dielectric strengths are high and range from 500-4,000 volts/mil, depending on the thickness. The dielectric strength decreases somewhat at 50°C, but then is relatively constant to 250°C (480°F) (Figure 4).

The excellent electrical properties of "Teflon" are a consequence of its symmetrical structure. Since "Teflon" is symmetrical with respect to fluorine substitution, dipole forces are effectively neutralized. As a result, the dielectric constant and dissipation factor are very low.

"Teflon" is extremely stable at high temperatures. It can be used continuously up to 260°C (500°F) and in special applications to just below its 327°C (620°F) crystalline melting point. As is evident from Figure 5, the weight loss even at 300°C (570°F) is extremely small, only 0.0002%/hour. At temperatures above 200°C (400°F), the weight loss is caused by a very slow depolymerization and minute amounts of toxic gases are given off. All high temperature operations involving "Teflon" should therefore be conducted in a well-ventilated area. The thermal behavior of "Teflon" above 400°C (750°F) has recently been reported by Madorsky and co-workers. (12).

The very good thermal stability of "Teflon" is another consequence of the very strong primary chemical bonds present in the molecule. The high crystalline melting point of 327°C (620°F) reflects the symmetry of its structure. If another atom is introduced into the chain in place of a fluorine atom, the symmetry is destroyed and the melting point, of course, goes down.

Reference has been made in several instances to the crystalline melting point of "Teflon". Although it is classed as a thermoplastic resin, it should be mentioned that "Teflon" does not flow upon melting as do most conventional plastics. When heated above 327°C (620°F) the normal crystalline structure is destroyed and "Teflon" changes to an amorphous, rubbery, transparent gel that does not flow to any appreciable extent. The lack of fluidity in the melt or, in other words, the extremely high melt viscosity is a direct consequence of the very great molecular weight of "Teflon." A high molecular weight, on the other hand, is necessary to achieve adequate mechanical properties. For an understanding of why this is necessary, reference must again be made to the low secondary valence forces in the true fluorocarbons. It has been mentioned previously that strength properties in high polymers are dependent on the nature and extent of the forces binding adjacent chains to one another. The stronger these forces are for a given segment of the polymer chain, the lower need be the molecular weight to confer adequate strength. Interchain forces are additive and strength properties generally increase with increasing molecular weight, then level off at some critical molecular weight. Melt viscosity, on the other hand, continues to increase indefinitely with molecular weight. The interchain forces in "Teflon" are weak as compared, for example, to nylon and consequently the molecular weight must be very high to confer adequate mechanical strength. At these high molecular weights, however, "Teflon" has an extremely high melt viscosity. In other words, if we want good mechanical properties we have to take the high melt viscosity that goes along with these properties. Fabricating techniques similar to those used in the dry process porcelain and powdered metals industries are needed to mold this polymer, since the high melt viscosity precludes the use of conventional injection molding equipment. Producing successful moldings is quite simple, however, once the know-how has been acquired, and there are now many plastics fabricators who are routinely doing high-quality "Teflon" molding.

The high melt viscosity is, in another respect, a blessing in disguise for it prevents embrittlement after long service at high temperature. Highly crystalline polymers are often subject to brittle failure, particularly where a dynamic application involving repeated stressing is involved. By shock cooling after molding, crystallinity can often be reduced sufficiently so that brittle failure is minimized or eliminated. If the fabricated part is used at elevated temperatures, however, the polymer will crystallize slowly and ultimately a brittle failure will occur. Because of the very high melt viscosity, the crystalline structure in "Teflon", on the other hand, is extremely stable at temperatures as high as 300°C (570°F). As a consequence, "Teflon", unlike other high temperature plastics, does not embrittle on continued exposure at very high temperatures.

At the other extreme, "Teflon" is not brittle at temperatures as low as 4° absolute (-269°C, -460°F). C. A. Swenson of the Cryogenic Engineering Laboratory, Massachusetts Institute of Technology, was interested in finding a material that was reasonably plastic in the liquid helium temperature range. (13) Of all the materials tested,

Figure 4

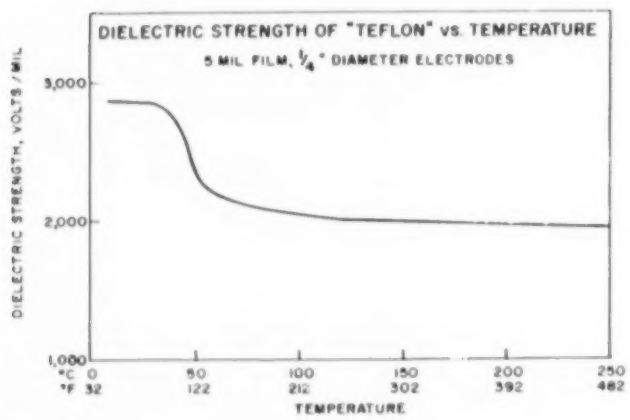
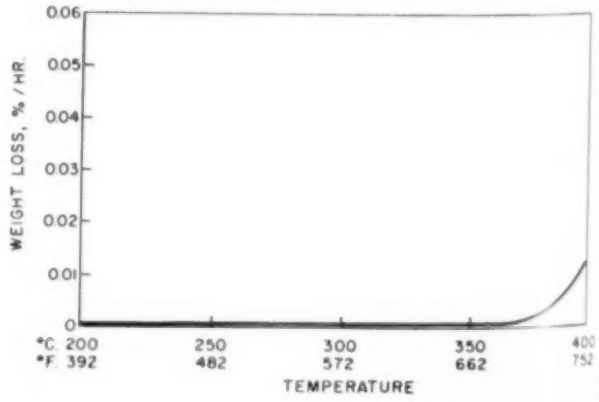


Figure 5
Weight Loss of Granular "Teflon" In Air



"Teflon" alone did not exhibit brittle behavior at these very low temperatures. His experiments showed that even at these low temperatures there was an elastic region, followed by an elastic limit, after which plastic deformation up to several percent was observed. The yield strength as a function of temperature is shown in Figure 6.(13) Polyethylene and polychlorotrifluoroethylene, on the other hand, at 4° absolute showed brittle failure at 25,000 and 44,000 psi, respectively.

The various properties that have been discussed, the outstanding chemical and thermal resistance, nonadhesiveness and low friction, and to an extent the excellent electrical properties, are all inherent functions of the polytetrafluoroethylene molecule and are virtually independent of how the polymer is fabricated. Mechanical properties, on the other hand, are markedly dependent, as they are with all plastics, on the quality of the molding and on the subsequent thermal history. Some average properties for well-molded samples are given in Table IV.

Form Stability Under Load

There has been some misunderstanding in the past with respect to the form stability of "Teflon" under load. The behavior of "Teflon" after long-time compression below the yield point at various temperatures is shown in Figure 7. These curves illustrate that the creep or cold flow of "Teflon" is confined to the first few hours after the load is applied and that at any given temperature an equilibrium state is rapidly achieved after which the molded object is quite form stable.

It is apparent from Table IV that the mechanical properties of "Teflon" at room temperature are adequate for many applications but that they are not outstanding. Although many plastics are stronger or stiffer at room temperature, there are no plastics that retain useful mechanical properties over as wide a temperature range as does "Teflon". The data from Figures 8 and 9 indicate that "Teflon" retains mechanical strength adequate for

Figure 6
Low Temperature Compressive Yield Strength of "Teflon"

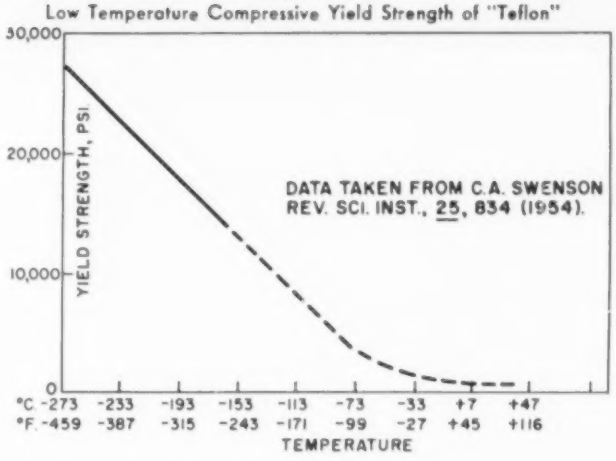


Figure 7
Effect of Long-Time Compression on Solid "Teflon," 1,000 Psi

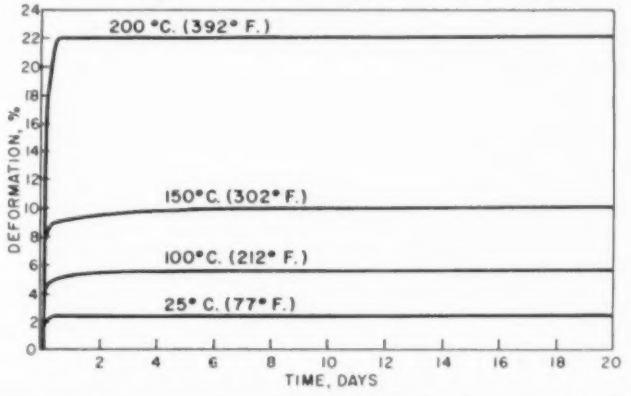


TABLE IV
Physical Properties of "Teflon"

Property		Method
Tensile strength, 73°F	1500-3000 lb./sq. in.	D638-52T
Elongation, 73°F	100-200%	D638-52T
Flexural strength, 73°F	did not break	D790-49T
Stiffness, 73°F	60,000 lb./sq. in.	D747-48T
Impact strength, Izod— 70°F	2.0 ft.-lb./in.	D256-47T
73°F	3.5 ft.-lb./in.	D256-47T
170°F	6.0 ft.-lb./in.	D256-47T
Hardness, durometer	D55-D70	D676-49T
Compressive stress at 1% deformation, 73°F	600 lb./sq. in.	D695-52T
at 1% offset, 73°F	1000 lb./sq. in.	D695-52T
Deformation under load, 122°F		
1200 lb./sq. in., 24 hrs.	4-8%	D621-43
2000 lb./sq. in., 24 hrs.	25%	D621-51
Heat-distortion temperature, 66 lb./sq.in.	250°F	D648B-45T
Coefficient of linear thermal expansion per °F, 77-140°F	5.5×10^{-5}	D696-44
Thermal conductivity, 0.18 in.	1.7 B.T.U./hr./sq. ft./°F/in.	(1)
Specific heat	0.25 B.T.U./lb./°F	
Water absorption	0.0%	D570-42
Flammability	nonflammable	D635-44
Specific gravity	2.1-2.3	D792-50T
Resistance to weathering	Excellent (2)	

Tests have been performed by A.S.T.M. methods unless otherwise indicated. Data shown are average values and should not be used for specifications.

(1) Thermal conductivity measured by Cenco-Fitch apparatus.
(2) No detectable change after 10 years of outdoor exposure in Florida.

Celanese

CORPORATION OF AMERICA

Announces

the first commercial production of

*

(CELLULOSE PROPIONATE PLASTIC)

High Performance Thermoplastic Molding Material with Outstanding Range of Balanced Properties... Available in Choice of Colors and Formulations

Forticel is not a new plastic. It was first introduced on a semi-works basis a number of years ago by Celanese Corporation of America, and quickly won a favored position among thermoplastic molding materials. Its unique combination of great strength with form retention literally dictated its use in such standard consumer applications as the telephone set in black or colored, appliance housings, the fountain pen and other end uses subject to personal contact.

An Overnight Reputation

Applications like these quickly put Forticel in the forefront position among thermoplastic molding materials. Forticel had the qualities needed by molder and manufacturer. In addition to its toughness and dimensional stability, this cellulosic plastic possesses unusual weatherability, surface beauty and permanence, color, and, perhaps as important as anything else, Forticel is free of objectionable odor.

A Molder's Plastic

In molding performance, Forticel is outstanding. Flow temperatures are not as critical . . . welds are stronger . . . surface details of molded parts are superb . . . flash lines are all but invisible . . . molded surfaces are lustrous, and require little or no buffing or polishing . . . molded-in metal inserts hold firmly.

A Fabricator's Plastic

Forticel also machines well. It can be sawed, cut, drilled, threaded and punched with far less danger of stress lines and crazing. This machinability is of vital importance in such applications as fountain pens and mechanical pencils, toothbrush handles and scale model trains, and appliance housings.

First Production of Forticel Stopped

When originally introduced, Forticel was produced in a pilot plant operation. And, because of the difficulty of obtaining raw materials of acceptable quality and cost, commercial production was delayed until such a time as raw materials could be produced in volume—at a price that would insure a competitive position for Forticel.

Production of the New Forticel Begun

After continued development, the new Forticel is currently moving into full scale production. More important to molder and manufacturer is the news that the raw materials of Forticel are *Celanese produced*—and in volume!

New Facilities For Forticel

To be certain that the supply of Forticel raw materials will be adequate to meet the anticipated demand for this outstanding plastic, Celanese has installed new facilities for their production. This will insure a dependable source of supply. These facilities will produce Propionic Acid and other petrochemicals necessary to Forticel manufacture.

The New Forticel

What about the new Forticel? What is it like? What makes it the right plastic for appliance housings, automotive steering wheels, accessories, scale models, sunglass frames, fountain pens, etc.? In the first place, today's Forticel is an even better plastic than its predecessor. This is the result of continued research into the development of new plasticizers, and improvements in processing.

A cellulosic, Forticel has *natural* impact strength or toughness. This is combined with a fine balance of desirable properties including, form retention, low mold shrinkage, weatherability and surface hardness. The new Forticel is available in a full color range, and supplied in uniform pellet size. Sample quantities are available for evaluation. The New Product Bulletin, NP-16 is ready for distribution. This bulletin covers the complete Forticel story from chemical and physical properties to molding and fabricating.

Celanese Corporation of America, Plastics Division, Dept. 000-M, 290 Ferry Street, Newark 5, N. J. Canadian affiliate, Canadian Chemical Company, Limited, Montreal, Toronto and Vancouver.

Typical Physical Properties of Forticel

Flow temperature	(°C.) (A.S.T.M.)	D569-48	**167—178**
Specific gravity		D176-42T	**1.18—1.21**
Tensile properties:	Yield (p.s.i.)	D638-52T	**3380—5020**
	Break (p.s.i.)	D638-52T	**3470—5240**
	Elongation (%)	D638-52T	**56—66**
Flexural properties:	Flexural strength (p.s.i. at break)	D790-49T	**6400—8500**
	Flexural modulus (10^5 p.s.i.)	D790-49T	**0.23—0.30**
Rockwell Hardness:	(R scale)	D785-51	**62—94**
Izod Impact	(ft. lb./in. notch)	D256-43T	**2.7—11.0**
Heat distortion	(°C.)	D648-45T	**59—70**
Water absorption—	% Sol. lost	D570-42	**0.00—0.08**
	% Moisture gain	D570-42	**1.5—1.8**
	% Water absorption	D570-42	**1.6—1.8**

Celanese® PLASTICS

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TABLE V

Change in Mechanical Properties of "Teflon" with Temperature

Property	Temp. Range	Equation
Tensile Strength	19°C to 300°C 66°F to 570°F	log (Tensile Strength) = log 54 + [(2.3 × 2350)/(10.7 × T)]
Flex. Modulus	19°C to 300°C 66°F to 570°F	log (Flex. Modulus) = log 890 + [(2.3 × 2580)/(10.7 × T)]
Yield Point	19°C to 300°C 66°F to 570°F	log (Yield Point) = log 48.3 + [(2.3 × 2250)/(10.7 × T)]

Temperature is in degrees absolute (C° + 273).

many applications at temperatures approaching its 327°C (620°F) crystalline melting point. When plotted against reciprocal absolute temperature on a semi-log scale, tensile strength, yield point, and flexural modulus follow straight line relations up to 300°C. The break in the initial portion of these curves represents a 19°C (66°F) first order transition temperature. Variation in these properties with temperature between 19°C (66°F) and 300°C (570°F) can be expressed by the empirical equations listed in Table V. Elongation increases rapidly with increasing temperature up to 50°C (120°F) then is virtually independent of temperature up to the melting point (Figure 9). To show how well the mechanical properties of "Teflon" are retained at high temperature in comparison with other plastics, plots of the tensile strength and flexural modulus of several familiar plastics are given in Figures 10 and 11. It is apparent from these data that the change in properties with temperature for "Teflon" is much less abrupt than with the other plastics cited and that "Teflon" has excellent retention of its properties up to its 327°C (620°F) crystalline melting point.

As an extreme example of its utility at high temperature, "Teflon" has been used in our own laboratories as a totally confined gasketing material at a temperature of 500°C (930°F) under a pressure of 15,000 psi. This is possible because of the remarkable but little known phenomenon by which the melting point of "Teflon" is raised with increasing pressure. (14) Thus the useful mechanical properties associated with "Teflon" below the melting point can, in certain specialized applications, be extended to considerably higher temperatures. The known utility of "Teflon", from 4° absolute (-269°C, -460°F) to 500°C (930°F), thus spans a temperature range of almost 1400°F, twice the range of any other plastic now known.

"Teflon" not only has useful properties at elevated temperatures, but it also retains these properties after long-time exposure at high temperatures. After one month at 250°C (480°F), molded bars showed only a 1 per cent loss in tensile strength; after one month at 300°C (570°F),

(Please turn to page 30)

Figure 8

Tensile Properties of "Teflon" as a Function of Temperature

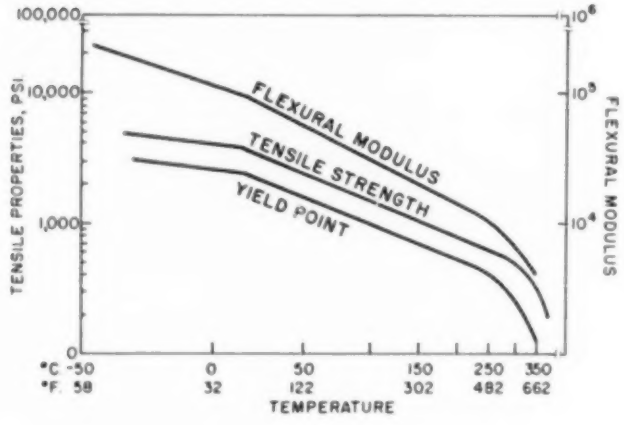


Figure 9

Elongation of "Teflon" vs. Temperature

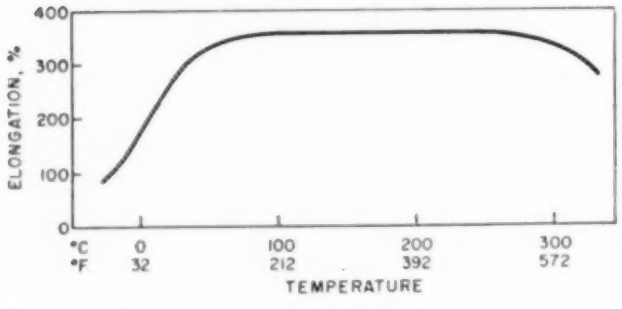


Figure 10

Tensile Strength vs. Temperature

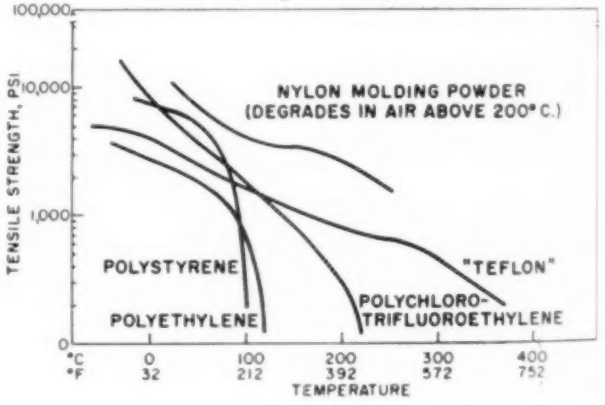
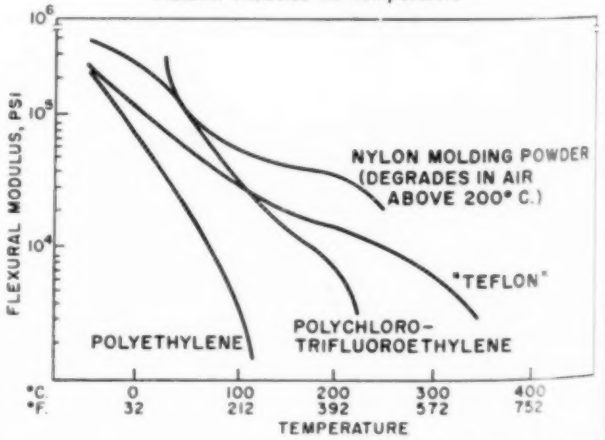


Figure 11

Flexural Modulus vs. Temperature



Stock Thermocouples, Pressure Gauges, and Rupture Disks for use on Plastics Extruders

E. C. Bernhardt

Sales Service Laboratory
Polychemicals Department
E. I. duPont de Nemours & Co.

The usual function of a plastics extruder is to supply molten polymer to a die at a given temperature, and uniform pressure. To check the performance of a plastics extruder, it is therefore desirable to determine the actual temperature and pressure of the melt as it leaves the barrel. These measurements are of particular importance to the plastics processor, because they give him an accurate check of the properties of the melt leaving his machine and enable him to control the uniformity of his output and reduce the loss of material during start-up. Until recently, stock thermocouples and pressure gauges for use on plastics extruders were used primarily for research purposes.

This paper illustrates thermocouples and pressure gauges which have been specially designed for use on standard plastic extrusion equipment. A simple safety device to guard against the build-up of excess pressure in the extruder head is also described.

STANDARD FITTINGS

All three of the devices mentioned in this paper are joined to the extruder, using a ½ inch 20-NF fitting (Figure 1), which provides a simple and convenient standard. This fitting provides a tight seal which easily withstands the pressures encountered in plastics extrusion equipment.

All of the instruments described here can be easily removed, and when they are not needed can be replaced with blank bolts which seat flush with the inside face of the extruder body.

STOCK THERMOCOUPLES:

Extruders are commonly fitted with thermocouples in the barrel wall and in the body of the extruder head and die. These couples provide accurate means for measuring the machine metal temperature. It is, however, incorrect to assume that the temperature of the stock and of the machine must be the same. The stock temperature can be lower than the machine temperature, or it may rise above, due to the dissipation of mechanical energy in shearing the viscous melt as it is conveyed along the screw channel. In actual practice it has been found that stock temperatures may vary from barrel temperature by 20°F or more.

There is a great need for measurements at the extruder head or die adapter to determine whether the stock has reached the desired temperature in its path along the screw channel. In dies containing long manifolds, stock thermocouples along the manifold are needed to control effectively the melt temperature gradients within the die. The problem has therefore presented itself how to obtain direct stock temperature readings with accuracy.

Stock thermocouples should satisfy the following requirements as closely as possible.

(1) The thermocouples should be thermally insulated from the metal body of the extruder, and should be in intimate contact with the melt whose temperature is to be measured.

(2) The thermocouples should be built into a small standard fitting which is easily removable.

The thermocouple construction shown in Figures 2 and 3 has been designed to meet these requirements. Thermocouples of this design are commercially available from the Thermo Electric Company, Saddle River Township, New Jersey.

The thermocouple weld is located at the tip of a ⅛-inch stainless steel tube. This stainless steel tube is silver-soldered into a ½-inch 20-NF head bolt. The bottom seat of the bolt is machined to provide a leak-proof joint, as shown in the drawing. The thermocouple may penetrate beyond the fitting into the melt to various depths. Figure

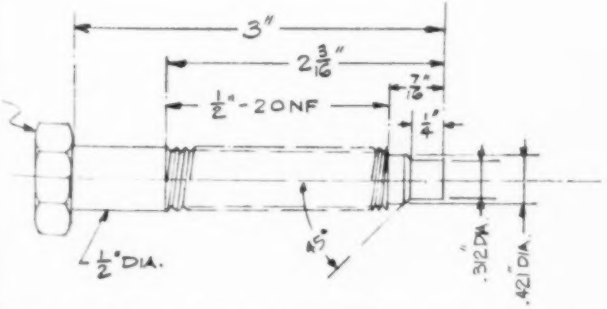


Figure 1. Standard fitting for thermocouples, gauges and rupture disks.

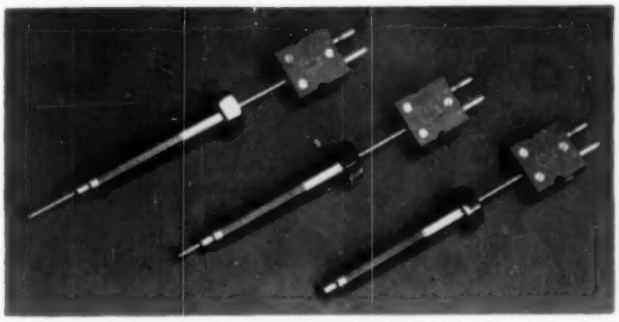


Figure 2. Photo of stock thermocouples.

3A shows a couple with a 1-inch penetration, 3B has a ½-inch penetration, and 3C is flush with the fitting.

THERMAL INSULATION:

The stainless steel tube in which the thermocouple is mounted will tend to conduct heat between the thermocouple and the body of the fitting.

This heat conduction will be a function of the tube diameter, and of the tube length. For a ⅛-inch tube, the influence of the temperature of the fitting becomes appreciable if the tube length is less than one inch. For this reason, all of the thermocouple tubes are insulated from the body of the fitting for at least one inch. In the case of the couples with the ½-inch penetration and the flush mounting, this thermal insulation is provided by sleeves of "Teflon" tetrafluoroethylene resin, as seen in Figures 3B and 3C. For the thermocouple penetrating one inch beyond the fitting, no insulating sleeve is required (Figure 3A).

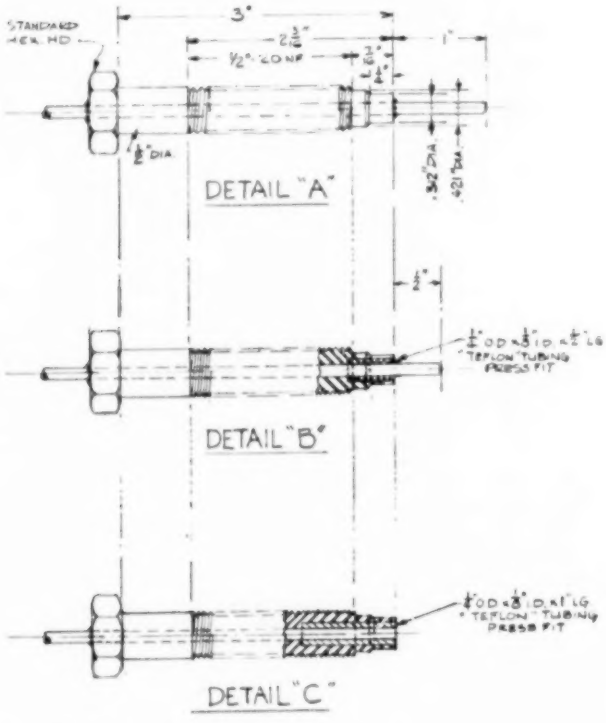


Figure 3. Construction details of thermocouples.

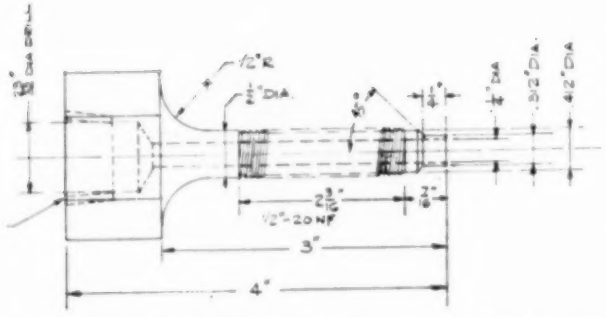


Fig. 4. Pressure gauge adapter tube made of 1½" hexagonal cold rolled bar stock.

SUGGESTIONS FOR THE USE OF THE STOCK THERMOCOUPLES:

Depth of Immersion. As a general rule, it is best to penetrate as close to the center of the melt stream as possible. In this way, the most reliable stock temperature reading can be obtained, and the effect of the barrel temperature is minimized. The one-inch long ⅛-inch tube is sufficiently rigid that it can stand at right angles to the direction of flow of the commonly used plastics at their normal melt viscosities without being bent. The thermocouples of 1-inch, ½-inch, and no penetration, cover the range of immersions most frequently needed.

Removal of Thermocouples during Shut-downs—When the extruder is shut down, we have found that as the machine cools, the stock held in the die and head of the extruder may cool and shrink non-uniformly. It may thus cause a small movement of extremely viscous stock which may bend or damage the thermocouple. We therefore find it advisable to remove stock thermocouples before cooling down the extrusion equipment during a shut-down.

PRESSURE GAUGES

J. F. Carley had published a paper on the design of a modified Bourdon gauge for measuring pressure in polymer processing equipment (1). The gauge and fittings described in the following paragraphs have evolved from this original design by Carley.

Construction of the Gauge:

The guage consists of two parts—a standard Bourdon tube gauge modified to incorporate a small vent port at the end of the tube, and an adapter tube (Figure 4).

The small vent port is used in filling the Bourdon tube with grease. It allows the air to escape as the Bourdon tube is being filled.

Two types of vents for the Bourdon tube have been used successfully.

(1) A standard type Bourdon tube gauge can be used and a small vent hole may be drilled into the end of the tube.

(2) A gauge supplied by the manufacturer with a built in capillary bleeder can be used.

If a standard Bourdon gauge is employed, and is to be modified by drilling a small vent hole into the end of the tube, the hole is tapped so that it can be closed with a 2-56 flat head screw. A perfect seal is assured by coating the under-side of the screw head with a thin layer of soft solder. As the screw is tightened, the solder forms a tight seal between the head of the screw and the end of the Bourdon tube.

A gauge supplied by the manufacturer with a built-in capillary bleeder can be used as received, without mechanical modifications, and is therefore simpler to put into operation. A schematic diagram of a capillary bleeder gauge is shown in Figure 5. Bourdon type gauges with capillary bleeders are available from gauge manufacturing companies, such as Acragage Corp., Milford, Conn., and Manning, Maxwell & Moore, Inc., Stratford, Conn.

Bourdon type pressure gauges come in ranges which easily cover the pressures encountered in plastics extruders. For ordinary pressure measurements on extruder dies, we find gauges of the 1000 psi or 2500 psi range most useful.

The assembled Bourdon tube and adaptor are filled with Dow Corning high-vacuum silicone grease. The complete assembly is shown in Figure 6.

Filling the Gauge:

On assembling the pressure gauge and adapter, it is

important that all parts be completely filled with grease and that no air be entrapped in the system. Any air left in the system would be greatly compressed when the gauge operates at high pressure and will consequently cause excessive motion of the grease in the system. In this way, it will contribute to the contamination of the grease with the plastic melt.

The following suggestions for filling the gauge are particularly designed to avoid air entrapment. The grease is pushed into the gauge with a grease gun. Any standard gun, e.g., the Lincoln Engineering Company (Model 1058) works well. In filling the gun, care must be used to avoid entrapment of air in the grease. The gun should have the standard ½-inch 20-NF female fitting, so that the entire gauge assembly can be attached to it.

The adapter and gauge, with the vent hole or the capillary bleeder at the end of the Bourdon tube opened, is now fitted to the grease gun, and grease is pumped into the assembly until it extrudes out the end of the Bourdon tube or out of the capillary bleeder. The grease gun is then removed from the gauge, and the vent hole at the end of the Bourdon tube is sealed, or the capillary bleeder is capped.

Installation and Maintenance:

The guage is now ready for use. It can be installed at any location where there is room for a ½-inch hole. In operation, a very small amount of grease at the tip of the adapter tube will be displaced by the polymer at the first start-up. This grease will be flushed through the extrusion die with the plastic. However, the plastic which has entered the adapter tube will generally not penetrate for more than one inch, and will in no way interfere with the operation of the gauge. The adapter tube should be checked periodically, and can be refilled with grease by simply removing it from the gauge and flushing it through with the fresh grease. No other maintenance is normally required.

Performance:

Several of the assembled gauges were calibrated with a dead-weight tester. The accuracy of the pressure gauges is not measurably affected by filling the tube with silicone grease. Readings within an accuracy of two per cent of maximum can be obtained without difficulty.

Response of the gauge is very rapid. We have used gauges of this construction in the barrel wall of a polyethylene extruder (2, 3), and were easily able to follow the cyclic variations in pressure caused by the movement of the screw thread at speeds of 150 rpm.

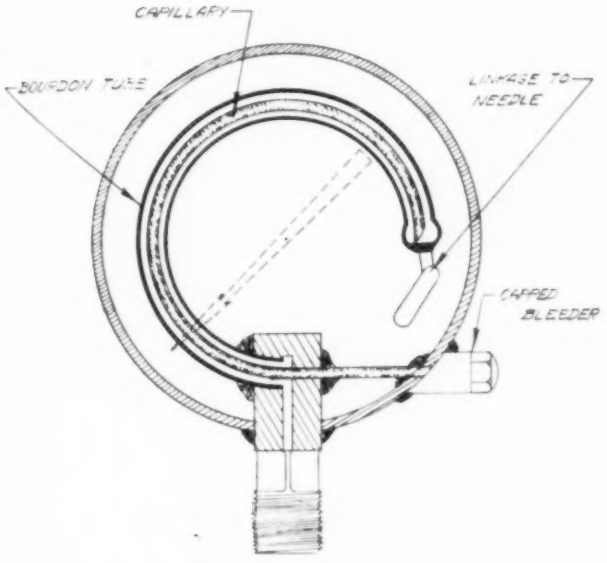


Figure 5. (above) Schematic diagram of capillary bleeder.

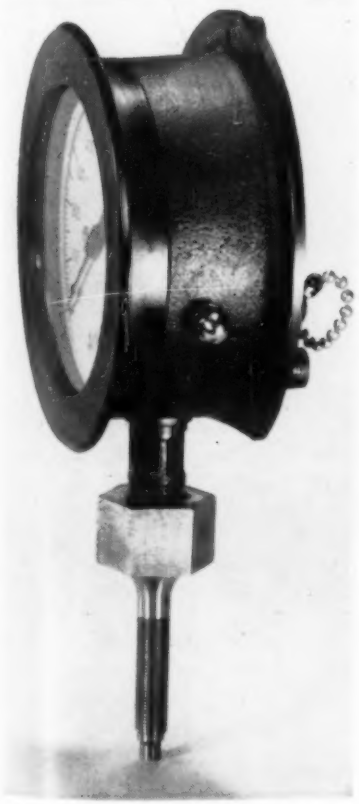


Figure 6. (left) Pressure gauge assembly showing capillary bleeder on side of housing.

RUPTURE DISK ASSEMBLIES

In some extrusion operations the danger exists that the die can plug up, and that excessive pressures can be set up in the extruder head as a consequence. This danger exists particularly with long-land cooling dies which might freeze, or in very small orifice dies which could be blocked by contamination or foreign matter.

Some extruder manufacturers protect their equipment against excess pressure through rupture devices at the head. We have found that rupture disk assembly can provide adequate protection in extruder heads which are not otherwise protected against excess pressure. They may be handy for protected extruder heads as well, be cause a rupture disk can be replaced very rapidly and easily.

Our rupture disk assembly is based upon the American Instrument Company rupture disk assembly. No. 406-204S. It is simply a short ¼-inch I.D. tube with a fitting which can be closed off with a thin metal disk. This disk will give or break at a known-pressure. Standard rupture disks for a wide range of pressures are available,

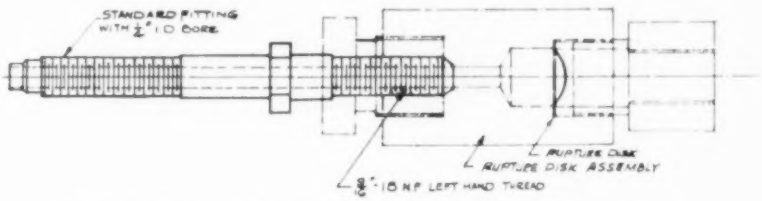


Figure 7. Schematic diagram of rupture disk assembly and adapter.

and consequently the extrusion equipment can be protected against any pressure desired.

The rupture disk assembly (Figures 7 and 8) is attached to the extruder through an adaptor tube which matches our standard ½-inch 20-NF fitting. The entire assembly up to the rupture disk is packed with the same silicone grease also used to fill the pressure gauge, and the same grease gun can be used to pack the rupture disk assembly as well. The function of the grease in the rupture disk assembly is to transmit the pressure from inside the extruder to the rupture disk, and to prevent the plastic melt from entering the assembly, freezing there, and thus rendering it ineffective. Just as in the case of the pressure gauge assembly, we have found that very little grease is displaced by the plastic melt during operation of the extruder. However, it is recommended that the adapter tube be periodically checked and refilled with fresh grease.

The rupture disk assembly is usually attached to the bottom of the die flange or extruder head, pointing to the ground. Should the rupture disk give, this position allows any extrudate to be guided safely into a bucket or container under the extruder head.

It is obvious that for very large extruders the ¼-inch tube of the rupture disk assembly may give only limited relief from excess pressure. Therefore, the extruder capacity and the viscous properties of the melt should be considered in the installation of this device. It is also obvious that the assembly described here would not protect the extruder against damage caused by the pressure generated in the start-up of a machine which has not been adequately preheated, and which is filled with frozen material in the extruder head.

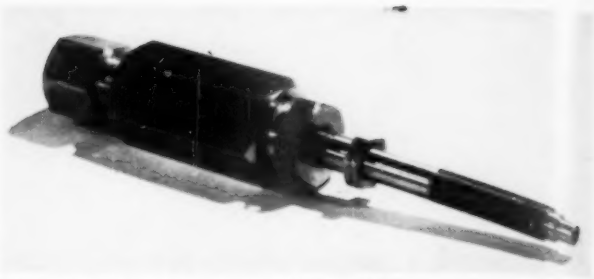


Figure 8. Photo of rupture disk assembly.

CONCLUSION

The three devices described in this paper have helped materially in the experimental extrusion work carried out by the du Pont Company. The stock thermocouples and pressure gauges aid in achieving balanced operating conditions quickly, and materially reduce the time for start-ups, and when operating difficulties are encountered they help in analyzing the true cause of the difficulties. The units described above are inexpensive, easy to maintain, and have been proven in a wide range of extrusion applications.

LITERATURE CITED

(1) Carley, J. F. "Modified Bourdon Gauge", **Ind. Eng. Chem. 45**, 858-60 (1953)

(2) Carley, J. F., McKelvey, J. M., "Symposium on the Theory of Plastics Extrusion", **Ind. Eng. Chem. 45**, 970-93 (1953)

(3) Bernhardt, E. C., McKelvey, J. M., "Adiabatic Extrusion of Polyethylene", **SPE Journal 10**, March 1954

Discussion

QUESTION: How tight a fit do you have to fit the thermocouple in the adapter?

ANSWER: It is not necessary to make special provisions to tighten this joint.

QUESTION: (1) What is between the tip of the pressure gauge and the grease in the Bourdon tube?

(2) If this is grease, does the melt tend to diffuse in the tube at all?

ANSWERS: (1) Nothing but grease.

QUESTION: (1) Can pressure gauges and rupture discs be used for P.V.C. Production—i.e. will the decomposed vinyl affect the operation of the gauges?

(2) Have pressure gauges any advantages for production machines?

(3) Is tip of pressure gauge mounted flush with stream flow?

ANSWERS: (1) We have not used these pressure gauges in the extrusion of P.V.C. However, we can see no reason why they should not work. Decomposed resin would not be able to get into the gauge.

(2) We believe that the pressure gauges are most useful in the analysis of operating problems or extrusion equipment. They give a clear picture of the restriction offered by the die, and make it possible to detect surges quickly. Once a standard operation has been established there is little need to keep a pressure gauge installed on the machine.

(3) Yes, it is.

(4) To make a recommendation it would be necessary to know the design of the screw, and the characteristics of the melt to be extruded.

QUESTION: When the assembly rupture disk pops, does it have to be cleaned of material?

ANSWER: Yes, it should be cleaned out and refilled with fresh grease.

QUESTION: Are thermocouples made that have retractable needles so that temperatures can be taken at different depths.

ANSWER: Thermocouples with retractable needles have been built, but we have not constructed any to match our standard fittings.

QUESTION: Have you ever experimented with, or successfully used diaphragm type gauges?

ANSWER: In order to use a diaphragm, we would need one of approximately ¼" diameter to cover the bottom of the adapter tube. This diaphragm would have to be exposed to the stream of melted plastic inside the extruder. We were not able to find a simple diaphragm gauge which could meet these requirements.

QUESTION: What is the order of difference of temperature when using thermocouple fittings inserted in the stream as compared to flush fit?

ANSWER: The difference in temperature readings you obtain between a thermocouple in the center of the melt stream versus a flush fitting one will, of course, depend on the temperature difference between the wall through which the thermocouple is inserted, and the melt. If the wall temperature is maintained very close to the reading obtained from the stock, there should be no error. If this is not done, we have observed errors of about 15°F.

QUESTION: Have you encountered damage to thermocouple through flow of high viscous materials?

ANSWER: If unusually low stock temperatures and extremely high viscosities are encountered, it is of course possible to damage these devices. In such a case a thermocouple with a shorter penetration should be used.

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KOPPERS DESIGN COMPETITION

Teflon Properties . . .

(Continued from page 24)

the tensile strength had decreased only 10 to 20 per cent.

SUMMARY

The combination of chemical and physical properties of "Teflon", unsurpassed by any other single material of construction, is a consequence of its true fluorocarbon structure. A combination of strong primary bonds in the polymer chains, weak secondary forces between the chains, and shielding of the carbon skeleton by a sheath of impervious fluorine atoms leads to the following outstanding properties:

(1) An almost universal chemical inertness,
(2) Complete insolubility in all known solvents below 300°C,
(3) Excellent thermal stability,
(4) Unique nonadhesiveness and low coefficient of friction,
(5) Unsurpassed electrical properties, including low dielectric loss, low dielectric constant and high dielectric strength,
(6) No embrittlement at very high or at very low temperatures,
(7) Outstanding retention of properties over a wider range of temperature than any other plastic now known.

REFERENCES

1. **J. F. Lontz, J. A. Jaffe, L. E. Robb,** and **W. B. Happoldt, Jr.,** "'Teflon' Tetrafluoroethylene Resin Dispersion. Extrusion Properties of Lubricated Resin from Coagulated Dispersions", Industrial and Engineering Chemistry, Vol. 44, p. 1805 (1952).
2. **R. N. Haszeldine** and **A. G. Sharpe,** "Fluorine and its Compounds", John Wiley and Sons, Inc., New York, New York (1951).
3. **B. S. Rabinovitch** and **J. F. Reed,** "Heat of Formation of CF_3 and Some Bond Dissociation Energies for Fluorocarbons", The Journal of Chemical Physics, Vol. 22, p. 2092 (1954).
4. **R. H. H. Pierce, Jr., W. M. D. Bryant,** and **J. F. Whitney,** "An X-ray Study of the Polymorphs of 'Teflon' Tetrafluoroethylene Resins", presented at the Spring meeting of the American Chemical Society, Buffalo, New York, 1952; **R. H. H. Pierce, Jr., W. M. D. Bryant** and **J. F. Whitney,** "Crystalline Phase Transitions in 'Teflon'", presented at the Fall meeting of the American Chemical Society, Chicago, Illinois, 1953; **C. W. Bunn** and **E. R. Howells,** "Structures of Molecules and Crystals of Fluorocarbons", Nature, Vol. 174, p. 549 (1954).
5. **M. M. Renfrew** and **E. E. Lewis,** "Polytetrafluoroethylene", Industrial and Engineering Chemistry, Vol. 38, p. 870 (1946).
6. **R. L. Scott,** "The Solubility of Fluorocarbons", Journal of the American Chemical Society, Vol. 78, p. 4090 (1948).
7. **J. B. Thompson, G. C. Turrell,** and **B. W. Sandt,** "The Coefficient of Friction of Steel on 'Teflon' Tetrafluoroethylene Resin", Society of Plastics Engineers Journal, Vol. 11, No. 4, April 1955.
8. **H. W. Fox** and **W. A. Zisman,** "The Spreading of Liquids on Low Energy Surfaces", Journal of Colloid Science, 5, p. 514 (1950); **K. V. Shooter** and **O. Taber,** "The Frictional Properties of Plastics", Proceedings of the Physical Society", Vol. 65B, p. 661-73 (1952).
9. **R. C. Bowers, W. C. Clinton** and **W. A. Zisman,** "Frictional Behavior of Polyethylene, Polytetrafluoroethylene, and Halogenated Derivatives", Naval Research Laboratory, Report 4167.
10. **A. R. von Hippel,** "Dielectric Materials and Applications", Technology Press of M.I.T. and John Wiley, New York (1954).
11. **P. Erlich,** "Dielectric Properties of 'Teflon' from Room Temperature to 314°C and from Frequencies of 10^2 to 10^5 C/S", Journal of Research of the National Bureau of Standards, Vol. 51, No. 4, p. 185 (1953).
12. **S. L. Madorsky, V. E. Hart, S. Straus,** and **V. A. Sedlak,** "Thermal Degradation of Tetrafluoroethylene and Hydrofluoroethylene Polymers in a Vacuum", Journal of Research of the National Bureau of Standards, Vol. 51, No. 6, p. 327 (1953).
13. **C. A. Swenson,** "The Mechanical Properties of 'Teflon' at Low Temperature", Review of Scientific Instruments, Vol. 25, p. 834 (1954).
14. **P. L. McGeer** and **H. C. Duus,** "Effect of Pressure on the Melting Point of 'Teflon' Tetrafluoroethylene Resin", The Journal of Chemical Physics, Vol. 20, p. 1813 (1952).

Twelfth SPE Conference . . .

(Continued from page 5)

Registration information and advance programs have been mailed to all members, and to the industry. Your early registration is solicited to eliminate the last minute rush of work for the Committee. Send your company registration or requests for further information directly to R. C. Lopez, The H. Muehlstein Company, 250 Jewett Street, Akron, Ohio, and your advance registrations as individuals to H. D. Oliver, Eastman Chemical Products, 1604 Terminal Tower Building, Cleveland, Ohio.

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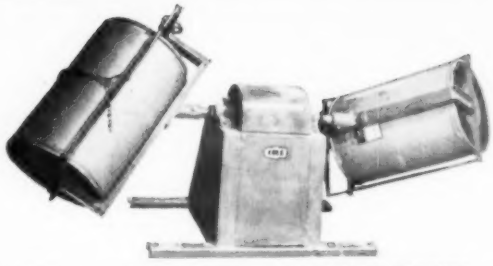

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AROUND THE WORLD

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AUSTRALIA

PLASTICS NEWS LETTER

Vol. 5, No. 1, April, 1955

Abstracter: Albert Lightbody

EMPRIC THEORY OF INJECTION MOLDED MOTTLES by L. Cohen

(This paper gained 1st place in the 1954 PIA Plastics Award.) A mottle is defined as a "pattern" formed by two or more colors in a thermoplastic material after the subjection of that material to certain thermal and mechanical processes and capable of reasonable repetition. The process of mixing, and the design of the mold, particularly of the placement of the gate, influance the design and the reproducibility of the design. These effects are discussed in some detail. An excellent paper in a little publicized field. Plastics News Letter.

★

FRANCE

INDUSTRIE DES PLASTIQUES MODERNES

Vol. 7, Nos. 6 & 7, June through August, 1955

Abstracter: Hans Mayer

REPORT ON REINFORCED PLASTIC TOOLING IN THE USA.

The use and manufacture of plastic dies or die parts, particularly for the automotive industry, are described. The materials employed and the considerations in the choice of the proper base materials are discussed.

THE MANUFACTURE OF VINYL BALLS.

The molding process and the machinery developed for that purpose by National Latex Products Co. are described.

A LEAK DETECTOR SYSTEM FOR PLASTIC, SUBTERRANEOUS PIPING.

Description of a method to detect leaks in subterraneous piping systems without digging out the pipe is given. The basis of the system is the introduction of restrictions in the piping system.

THE SHOCK RESISTANT POLYSTYRENES:
G. Lemiitre.

A discussion of the various types of shock resistant materials based on copolymerization. Tubing and pipes from polymides. — Newly improved materials, methods of production and end uses, developed for the finished product, are enumerated.

★

GERMANY

KUNSTSTOFFE

August, 1955

Abstracter: Anne Schwend

HIGH POLYMERS. Part 1, Molecule and Material Properties:
Dr. Ottmar Leuchs

The maze of new plastic materials developed during the last decade asks for a systematical and technically applicable order on a scientific basis for all high polymers to keep this complex field under control. Scientists have therefore attempted to uncover the interrelationship between the properties of plastic materials and the molecules of which they are composed. This subject has been aired from various angles before with particular emphasis on the determination of the influence of the molecular weight. This factor, however, is of minor importance in the comparison of high polymers of different chemical structure. On the other hand, the form of the molecules of a plastic material and the strength of attractive forces between individual molecules and parts thereof, i.e. the intermolecular forces, if known, will reveal much about the hardness, resistance to temperature and solvents, processing possibilities, etc., of the material under consideration. Hence, the most important findings about the shapes of molecules and intermolecular forces are laid down in this survey which constitutes a contribution to the international standardization of concepts and has already been considered by the German Standardization Committee upon re-issuance of Standard DIN 7708 — Plastics and Types of Molding Compounds.

THIRD BRITISH PLASTICS CONVENTION AND FAIR IN LONDON, JUNE 1955:

A survey of papers presented at the convention and new machinery as well as plastic products exhibited.

PLASTICS AT THE ACHEMA FAIR FRANKFURT/MAIN:
Dr. Erich Escales

The 11th ACHEMA Fair in May, 1955 gave a comprehensive survey on the utilization of plastics and application of plastic parts in manifold form in the chemical industry. This is but a brief review of possibilities shown.

MILAN CONVENTION ON MACROMOLECULAR CHEMISTRY:

Review of papers presented on progress in the kinetics of polymerization and the properties of macromolecules which gave an excellent view of today's international standard of high polymers.

MEASUREMENTS OF CREEP OF ACRYLIC GLAZING PLASTICS:
Murray C. Slone & Frank W. Reinhart

Excerpt from SPE Journal December 1954.

INJECTION MOLDED CONNECTION OF PARTS:
Fritz Schaupp

Description of the possibility of bonding polyamide and polyethylene parts, which are highly resistant against solvents and normally could only be bonded with concentrated acids, by molding a connecting link onto the assembled parts.

DESIGN OF INJECTION MOLDS:
Hans Gastrow

Description of molds with tang break-off tools and two parting lines.

ONE GRAND

See Page 41

GREAT BRITAIN

BRITISH PLASTICS

Vol. 28, No. 5, May 1955

Abstracter: E. A. J. Mol

APPLICATIONS FOR PLASTICS IN THE MANUFACTURE OF STORAGE BATTERIES—pp 160-163

Development in storage batteries, especially during the war, have led to the introduction of new materials. The most important of these (by volume) are polyvinylchloride and polystyrene; for certain jobs polyethylene, nylon and polyester/glass are also employed.

For heavy duty batteries, the most important advance to give improved performance is the introduction of microporous PVC-separators, replaceing the wooden one. Glass fibre/impregnated Kraft paper separaters are also in use, both outlast the plates in any type of battery. For the vent plugs, porcelain and acid resistant phenolics have both beeb superseded by general purpose polystyrene. Light weight batteries use plastics for constructional purposes, including containers, cases and covers.

GRAPHITE FILLED MATERIALS FOR WATER METER COMPONENTS — pp. 174-175

Measuring chamber and intermediate gears of a water meter are injection molded in self lubricating, non corrodable graphite-filled polystyrene and graphite-filled nylon respectively. Details of mold construction and of finishing to close tolerances are given.

MODERNIZATION OF A COMPRESSION MOULDING SHOP. — pp 177-181

Illustrated description of what modernization can do to improve efficiency and quality of compression molding. The "before" picture certainly justifies the action taken in this particular company (M. K. Electric, Ltd.). In the modernized plant, the lay-out has been planned to streamline production, prevent cross contamination and promote general cleanliness. An underground Bipel drive unit supplies the hydraulic power for a group of presses. Almost all lines, including water, compressed air and electrical services are also located below floor level. Tool storage and tool handling has received particular attention, transportation of molds takes place with specially equipped fork lifts.

DIMENSIONAL VARIATIONS IN UREA FORMALDEHYDE MOULDINGS — M. Fuzzard, pp 192-193

Now that U.F. resins are used more and more in industrial applications, dimensional stability under adverse conditions is of even more importance than before. Experiments with different formulations showed that for constant dry heat the plasticized material is best; in high humidities the conventional formulations come out in front (less weight increase, less dimensional increase).

INSPECTING PLASTICS BY RADIOGRAPHY — p 191

Recently, Thulium 170, produced by the Atomic Energy Research Establishment at Hartwell, has been found suitable for use in the radiography of low density materials. (Other isotopes, used earlier are: Thallium 204, Strontium 90 and Cerium 144). Internal blisters, cracks, inclusions, shrinkage areas, resin deficiencies and delamination can be detected and the position of metallic inserts checked for misalignment and discontinuity. The radiation source is of low energy, no lead lined working area is required.

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NETHERLANDS

PLASTICA

Vol. 8, No's. 1, 2, 3

Abstracter: W. P. ter Horst

PLASTICA J-F-M

CHEMISTRY OF ORGANIC ISOCYANATES, E. J. Mouton, pp. 32-35

In these articles the principal methods of preparation, the reactions of the isocyanates with amines, water, alcohols, phenols and carboxylic acids and the most important applications in foam materials, coatings and adhesives are given.

Vol. 8, No. 6, June, 1955

SPHERULITES — G. Schuur, pp. 312-15

High polymers can crystallize in two different ways. Quenching and heating results in many small crystallites, oriented at random. During normal crystallization, however, an internal flow of the material occurs. This is called the auto-orientation mechanism, as the molecules orient themselves before crystallization takes place.

It is possible to explain the growth of spherulites in thin films on this basis. At comparatively low temperatures normal spherulites are formed, in which the molecules are tangentially oriented. At temperatures more near the melting point special spherulites are formed, in which crystallites, perpendicular to each other, are often found in each others immediate vicinity.

This demonstrates that the auto-orientation mechanism also plays an important part in the formation of these special spherulites. On the basis of these phenomena it is possible to explain the experimental facts that a high polymer never crystallizes in equilibrium conditions and that the melting point increases with increasing temperature of crystallization.

The crystalline material in quenched polymers may be discontinuous, but the crystalline material is continuous within the spherulites. This means that individual crystallites, separated by amorphous material, are non-existent in normally crystallized high polymers.

The dark circles and spots in spherulites, which are often observed through the polarizing microscope, are the result of an overlapping of crystallites, which are perpendicular to each other.

PLASTICA

Vol. 8, No. 8, August, 1955

DEVELOPMENTS AND EXPERIENCES IN THE MANUFACTURE OF LAY FLAT TUBING: P. Schenkel, PP. 396-400

Figures relating to the amount of polyethylene used in the U. S. A. in the manufacture of lay flat tubing are given.

Some production methods are discussed and the equipment used therewith is described in detail.

Finally attention is paid to dimensional control of the product obtained as well as to the raw materials used.

This article will be continued in some further issues of this journal.

POLYURETHANE RUBBERS: E. J. Mouton, PP. 404-407

This article deals with raw materials, properties, methods of processing and applications of the most important urethane rubbers: I-Gummi, Vulkollan, Chemigan SL, Adiprene B and Vulcaprene.

In many countries the development of these products is studied, but it will take some time before these products will be fabricated on a commercial scale.

(Please turn to page 39)

THE *Injection* MOLDERSCOPE

By A. R. Morse

President, Injection Molder's Supply Co.

"It is the freedom to disagree, to quarrel with authority, in intellectual matters to think otherwise, that has made this nation what it is today." Dr. James B. Conant

THE SERVICE MAN

In the injection industry, the unsung hero is the press maker's service man. As a salesman for one of the injection machine companies, it was painfully obvious to me that it wasn't MY salesmanship that really did the best selling, it was the service man—men like Sturgis Green, Tony Korzun and Whit Kendall that pulled the fat out of the fire and made the sale click, at the same time laying the ground work for the next sale.

The service man can perform two vital functions: he can bring back to the press maker urgent information on the design and function of the press, and he can make or break the next deal. The advice of the service man asked in designing new models as the category of field service is played down in some companies. One line of presses, for example, recently redesigned their hydraulic system to a manifold type. Instead of using a solid drilled block as any service man would have suggested, they used a sandwich type construction. Result? You guess! For my money, if I were building and selling a line of injection machines, I'd incline to dispense entirely with the hot-shot salesman and use the service man category for BOTH sales and service. These men would be well paid, including an incentive commission. They would be trained so they could distinguish a fault in the press from a fault in the mold or the material. And they would be an integral part of my engineering plans, with every idea they report given quick and careful consideration, personalities aside. Trouble is, it takes a great deal of time to train a good service man in the injection business—a man who can spot a rag in a pipe line, tell low line voltage by the sound of a machine, or wrestle heavy parts to install a new frame under woefully inadequate shop conditions.

I'd build on the service man's approach—a fellow who can make a press deliver the goods or know the reason why it won't work on a given job. Furthermore, there is no better way to learn about a competitor's press than from the plant angle. You can baby specifications very easily from a press on the run-off floor and feel quite proud of yourself, but you often cannot duplicate them on the molding room floor. True, you'd miss some top-level sales my way where the money-man or the front man buys from a sales folder, but in the long run you'd win by placing all your dough on the service man—the injection industry's unsung hero.

East New England

Materials Properties Are Outlined

A. I. Simon

The first combined meeting of the 1955 fall season of the Eastern New England Section of Plastics Engineers, and the Boston-Providence Section of Plastics Industry was held Thursday, September 22, 1955 at the Hotel Beaconsfield in Brookline, Mass., with over one hundred members and guests present. Mr. Harry Connors, President, presided at the meeting. The Treasurer's report for the last fiscal year was given by Ralph L. Mondano, Treasurer.

Mr. D. G. Welsh, Technical Service Representative of Hercules Powder Company, presented a talk on "Hercocel W", a new type of cellulose acetate. He showed slides on the comparison of costs, properties, and molding conditions of this material with other cellulosics. The cost of this material was stated as 56 cents per pound, the specific gravity as 1.25, heat distortion 225°F. at 66 psi, and a Rockwell hardness of 107. This material is not recommended for subzero application.

Mr. Howard H. Irvin, Chief Chemist of the Marbon Chemical Division of Borg-Warner Corporation, proceeded to discuss "Cycolac", a high impact co-polymer of butydiene, styrene, and acrylonitrile. He presented a series of slides comparing this material with other thermoplastics, such as high impact PVC, cellulose acetate butyrate, high impact styrene, nylon, and a rubber resin. Some of the factors compared were chemical properties, mechanical properties, and costs. It was claimed that the weld qualities of this material during molding were excellent.

Mr. Harry Voskamp, Product Manager of Barrett Division of Allied Chemical and Dye Company, then discussed "Plaskon Nylon 8200". He mentioned that an oriented nylon film, which shows promise for vacuum forming and packaging, has an appreciable increase in tensile strength over the unoriented nylon film.

The next S.P.E. meeting will follow along the same type of subjects, namely new thermoplastic developments. It is expected that low pressure polyethylene and irradiated polyethylene will be the subjects to be presented.

Toledo

Polyethylene Has "New Look"

D. E. Cordier

Approximately 30 members and guests attended the September 14 meeting of the Toledo Section, Society of Plastics Engineers which was held at Morgan's Lookout. The guest speaker was Mr. George H. Sollenberger of Koppers Company, Inc. who gave a comprehensive and interesting description of Kopper's new Super Dylan high-modulus polyethylene.

Highlights of the meeting in addition to Mr. Sollenberger's talk was the attendance of Mr. Jim Underwood, National Executive Secretary of SPE who presented a most encouraging summary of some of the future aims and goals of SPE. Another feature of the meeting was its designation as "Past President's Night" in honor of previous presidents of the Toledo Section. Several past presidents were present and were introduced.

Mr. Sollenberger described the Super Dylan polyethylene as a new plastic combining an unusual variety of properties with general superiority to standard polyethylene existing in its greater rigidity, tensile strength, heat resistance, toughness at low temperature and improved surface luster.

A wide variety of product applications was cited in which it is believed the improved properties of the new polyethylene will result in expanded polyethylene usage. Examples of such product applications include pipe, film, bottles, packaging applications, vacuum forming and housewares.

It was emphasized by the speaker that the polymerization process for Super Dylan has adequate flexibility to permit the production of a family of new materials possessing the desired variations in physical properties. Presently available are Super Dylan #6200 and #6600. The former type is used largely in injection molding and provides good surface gloss and intermediate strength properties. The type #6600 possesses superior strength properties but has somewhat poorer appearance, being used largely in pipe and wire insulation applications.

SECTION NEWS

Edited by
Stanley Bindman
Jamison Plastic Corp.
1255 Newbridge Road
North Bellmore, L. I., N. Y.

Newark

Merits Of Injection Molding And Vacuum Forming Debated

Robert Bostwick

The Newark Section opened the fall season on September 14 with a well-attended dinner and meeting. Approximately 140 members and guests were present, including a visitor from far-off Mexico.

Before the formal program, both Bob Bartlett and Pete Simmons gave brief reports and Bill Willert showed colored slides taken at the Spring outing. Bob Bartlett reported that the Section-sponsored plastics courses at Newark College of Engineering were over the hump but there was still a need for instructors. He urged any people who felt qualified to contact him. Pete Simmons reported on the last national meeting at Cleveland and the anticipated revision of Thomas' "Injection Molding of Plastics."

The subject of the evening's program was a panel discussion of "Economic and Production Comparisons between Injection Molding and Vacuum Forming," with Milt Sanders, of Sun Tube Company, as moderator.

The main speaker was Mr. O. H. Yoxsimer, Manager, Refrigerator-Freezer Engineering of Westinghouse Electric Corp. Mr. Yoxsimer confined his remarks to large area parts used in refrigerators and freezers made of polystyrene or polystyrene alloys. Large area parts were defined as those having an area between 800 and 2,000 square inches. The speaker drew on his experiences at Westinghouse to compare injection molding and vacuum forming as methods of fabricating such parts.

Mr. Yoxsimer pointed out that internal strains can occur in both molded and formed parts, with likelihood of fewer strains in the latter. Weld lines occur only in molded parts. Flow lines and orientation occur in both and are more readily forecast as a pattern in forming than in molding. Overheating can also occur in both and is currently more of a production problem in forming than in molding. Re-use of material is more safely done in forming than in molding. On individual shapes and contours, some are more readily done one way and some more readily the other. Formed and molded parts differ in appearance and acceptability is largely a personal matter.

Costs Discussed

On the subject of costs, the speaker showed figures for one design of inner door panel by both molding and forming from one supplier. While the molded parts were 4 percent cheaper per pound, the formed panels could be made 25 percent lighter in weight, leading to a lower cost per panel for vacuum forming. Summing up, Mr. Yoxsimer preferred vacuum forming for inner door panels as a specific illustration of large area parts.

The panel members commented briefly on Mr. Yoxsimer's talk before the general discussion period. Mr. Adolph de Matteo, Chief Engineer of the Watson-Stillman Co., stressed the importance of injection molding for pieces of complicated shape. Mr. Sanford Zimmerman of Vacuum Forming Corp. spoke on the growing use of formed parts in the automotive industry. Mr. Saul Blitz of Tico Plastics stated that for volume production of small pieces of the same thickness, injection molding was cheaper than vacuum forming. As the pieces increase in size, the gap between the two methods narrows.

Mr. Robert Barber of the Panelyte Division of St. Regis Paper Co. commented that even considering extrusion equipment for producing the sheet, capital outlay for vacuum forming is only 50 to 60 percent of that required for injection molding.

During the question and answer period it was brought out that there is some work going on now in the vacuum forming of low pressure polyethylene and also a laminate of Mylar and high impact polystyrene.

Door prizes were donated by Columbia Engineering and Beal Engineering.

Kansas City

Profit and Loss In Mold Design

John R. Albert

After dinner at Milleman's, on the Plaza, the first meeting this Fall was held the evening of September 6. Mr. J. E. Ferguson, President of the section, opened the meeting and gave a review of the organization and progress of the Kansas City SPE Chapter and outlined the anticipated speaker program for the coming year as planned by the entertainment committee.

The speaker of the evening, Mr. Wayne I. Pribble, President of Pribble Plastics Products, Inc. of New Haven, Indiana, gave a very educational and interesting talk on "Profit and Loss Factors in Mold Design" and the points he discussed are as follows:

TO INCREASE PROFIT

1. Keep Accurate Print and Mold Records.
2. Less Mold Cost.
3. Designer Controls Dimensions.
4. Mold Know How.
5. Molder Know Material.
6. Allow Time for Designing.
7. Don't be Afraid to Change Design.
8. Save Machine Time.
9. Have Conferences and Discussions on Mold Design.

TO DECREASE PROFIT

1. Never Check Mold When Making Changes.
2. Let Moldmaker Have His Way on Design.
3. Never Give Complete Information.
4. Neglect Design Time Merits.
5. Never Promote Good Designer.
6. Never Approve Design.

Door Prizes, of polyethylene donated by Spencer Chemical Company, were won by Stuart Thompson of Avsco, Inc. and Orville Kuhlman of Kuhlman Plastics, Inc.

ONE GRAND

See Page 41

Polyethylene Properties Told

George Snyder

A capacity crowd of over 90 members of the Western New England Section jammed the Terrace Dining Room at Bradley Field, Conn., On October 5, to hear an interesting prograess report on development work being done in the field of the "super" polyethylene resins. George H. Sollenberger, Technical Coordinator of Plastics Market Development, Koppers Company, Inc., was the principal speaker.

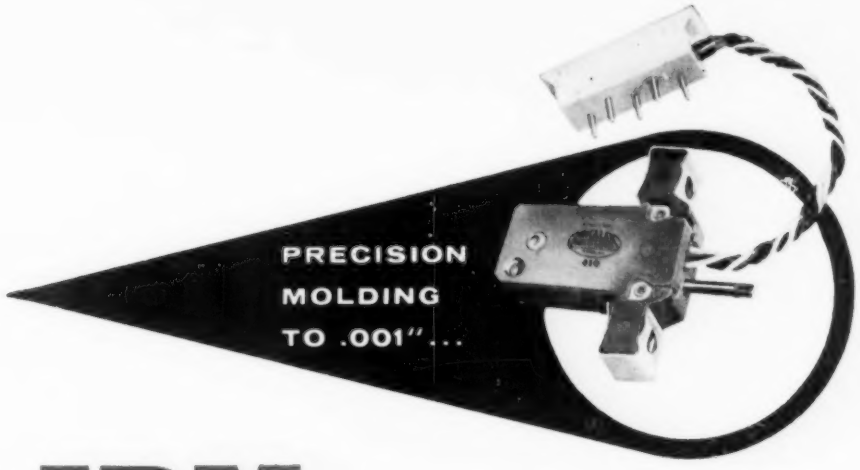
The results and analyses of various research and application tests on Koppers' Super Dylan polyethylene, were reviewed by Mr. Sollenberger. The term "super" polyethylene, he explained, refers to an ethylene polymer group which is also commonly known as "low presure" or "heat resistant" resin. Mr. Sollenberger frowned on the use of these property features as generic terms for the new material, however, stating that they do not reveal the true scope of possibilities for the super resins.

Heat resistance, he said, is only one of the important improvements in the new polyethylene group. Items molded of the super resin show about the same strength properties in boiling water tests that regular polyethylene exhibits at normal room temperature, he said. In a 15-minute, pressure steam test at 250°F., ordinary polyethylene test samples collapsed completely whereas items molded of the super polyethylene showed no visible change.

This heat resistance feature, combined with greatly increased toughness, tensile strength and rigidity makes the new polyethylene material valuable for pipe, kitchen ware, industrial housings, refrigerator parts and battery cases. In pipe applications, he said, the Super Dylan resin displayed about three times the burst strength of ordinary polyethylene pipe of the same dimensions.

Mr. Sollenberger closed his talk with a summation of the properties and advantages of the new material over the more commonly-known formulations and expressed the belief that the new super polyethylene resins would open up many new opportunities for plastics in molded, extruded and film applications.

Mr. Lewis Gustafson of the Prolon Division, Pro-phy-lac-tic Brush Company, was technical chairman for the evening; Mr. Arthur Logozzo, section president, was general chairman.



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Milwaukee

Sollenberger Speaks At First Fall Meeting

Marvin C. Stowe

The Milwaukee Section of the Society of Plastics Engineers held its first meeting after summer recession on September 13, 1955. Sixty members and guests attended.

After a dinner and a brief business meeting, Mr. G. H. Sollenberger of the Koppers Company Inc., was introduced.

Mr. Sollenberger talked to us on the new high temperature "super" polyethylenes. In mentioning a few of the highlights about these materials, he first said that the "super" polyethylenes retain all the good characteristics of the polyethylenes being used today.

Probably one of the most important of the many added characteristics in these new materials is its rigidity. It has slight pliability but of course not enough for such products as squeeze bottles, etc. Another good point about the material is that parts, such as baby bottles, can be boiled for sterilization purposes. You can get a high luster with the new "super" polyethylenes. A water tumbler was given to each of the members and guests as an example of some of these features.

These materials have an increased value for all polyethylene users, and prospective users as well. The extent of these new materials capabilities is far from being discovered. Various long term endurance tests, etc., are still in process. Mr. Sollenberger brought out that qualities have already been discovered in these new materials that can not be found in any present existing plastics, and a lot more can be expected in the future.

Baltimore-Washington

Section Has Largest Turnout In Its History To Hear Design Talks

Erling F. Rosholdt

The largest group to attend a meeting in the history of the Baltimore-Washington section turned out September 13 to hear Henry Perry, Jr., of the Naval Ordnance Laboratory, Washington, D. C., and Walter R. Chance of W. R. Chance Associates, Arlington, Virginia, present a program on "Design Criteria in Reinforced Plastics" and "Practical Applications of Design Criteria in Reinforced Plastics Structures."

Starting with the basic definitions and equations used in calculating the strength properties of reinforced plastics of various shapes under tensile, compressive, flexural, torsional and impact stresses, Mr. Perry presented data comparing strength, weight and cost per pound of rods, tubes, beams, and plates of reinforced plastic containing various forms of reinforcement, i.e., random fibers, random mat, type 181 cloth, x-ply parallel mat, and parallel roving glass fibers, with steel, aluminum, magnesium and the woods hickory, birch, and cedar, when used under different types of stresses. Examples of specific use of the data in various applications were given.

Mr. Chance, in his talk, pointed out that usually the design engineer working with reinforced plastics has to obtain his own test data for his specific problem. He divided reinforced plastics design into three types: low stress item, (fabrication being the main consideration); medium stress item, (semi-structural, with only an occasional high stress) and structural items, (with dead loads and high stresses). In the latter type the design engineer usually has rough going which may become better with more design criteria.

He listed the steps in handling a design problem as: (1) An economic feasibility study; (2) Consideration of the strength, weight, stability, balance, and service test specifications involved; (3) Use of the designer's knowledge of all phases of reinforcement, resins, laminating procedures, and tooling to delimit the problem; (4) Calculation of working stresses followed by construction details; (5) Test, development, then redesign as needed. Design is often on a trial and error basis or by comparison with known materials. Mr. Chance discussed the design and construction problems involved in the development of a prototype of a 50-foot reinforced plastic boat his firm made for the Navy.

In October, the Baltimore-Washington section will visit the Point Breeze plant of the Western Electric Company in Baltimore to view its extensive facilities for handling and using plastics.

ONE GRAND

See Page 41

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Dear Friends:

It seems that every time you get one of these notes, I have just made a talk somewhere or else there is one coming up in the near future. Several persons have asked me whether these talks "Pay-off." Of course, I would have to ask just what you mean. If you mean paying off in direct financial return, the answer is "No!". If you mean deferred payment, I would have to answer "Maybe!". If you mean satisfaction in contributing to better understandings, then the answer is "definitely, yes!". If you mean return in good will, the answer would be "Certainly!".

I believe it was Mr. Kraft (of cheese fame) who told his son, **"If you do only what you get paid for, you will never get paid very much."** I am sure you all agree that it is "the extra mile" that really counts.

I am pleased to report that October 12 was the date when I talked to a group of General Motors personnel at GM Technical Center in Detroit. December 14 will find me with the Kentuckiana Section in Louisville. See you all in Cleveland in January.

Yours for better living with plastics.

Wayne I. Pribble

WAYNE I. PRIBBLE

Central Indiana

Quality Control For Better Parts

C. R. Smith

Central Indiana convened its first Fall meeting at the Warren Hotel in Indianapolis on September 29th, 1955. Despite inclement weather and hordes of Thursday night shoppers that reduced parking space to a bare minimum, the meeting was well attended. Section President Gene Quear, announced that henceforth meetings would be held on the last Tuesday rather than Thursday of each month, to avoid crowds attending the large stores late Thursday night shopping hour. The Section Board of Directors is looking for an equally simple solution to the weather problem. A special word of thanks to our friends from Peru, Ind. and other outlying areas for making the long trip.

Announcement was made of a new membership drive to insure this Sections contribution to the goal of "5000 for '56". Raffle tickets will be awarded to sponsors of new applicants and a drawing for three attractive prizes will be held during the December meeting.

Speaker for the evening was Mr. George W. McDermott, Supervisor of Quality Control for the Delco Remy Div. of G.M.C. at Anderson, Indiana. Mr. McDermott is an experienced speaker of many years standing on the subject of Quality Control. The theme of his talk was to achieve a better understanding of Quality Control, its purposes and the men responsible for it in the plant. As he pointed out, it is not the intention of any Quality Control man to affix blame for poor parts on any one individual, but rather by analytical means to determine first the capabilities of a given process and then to establish whether or not the parts produced are within those capabilities. The Quality Control man should be used as a friend to assist in making good parts at the source, rather than a mere inspector to point out bad parts at the end of the line, when it is too late to take any corrective action.

The validity of Mr. McDermott's statements was forcefully illustrated through the use of dice and a specially designed pin-ball machine. With these props he demonstrated in a relatively few number of turns, representing parts, the frequency distribution that would exist for a much greater number of turns, representing a days production. By introducing known variables, it was simple to illustrate the effect of a deficiency in either machine or materials in the pattern of frequency distribution—and also how quickly it could be detected at the source with a good Quality Control set up.

ONE GRAND
See Page 41

Newark Die Expands

Islyn Thomas, General Manager of the Newark Die Company, 24 Scott Street, Newark, N. J. has announced that heavier milling equipment for production of larger molds has been installed.

A second shift has also been added to facilitate delivery of injection, compression and transfer molds for the plastic industry.

Additional floor space has also been made available to take care of the greater demands for plastic molds.

PHILLY MEETING DATE

Please note correction to listing on reverse side of membership cards. The meeting night of Philadelphia Section is the fourth Tuesday of each month.

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SCHEDULED SPEAKERS

W. F. Underwood
Visking Corp.

W. D. Lahey, Mgr.
B. F. Goodrich Chemical Co.

E. A. Edberg, Mgr.
Koppers Co., Inc.

T. M. Berby
American Viscose Corp.

E. V. Hellyar
Monsanto Chemical Co.

Mark Stringfellow, Mgr.
Spencer Chemical Co.

Robert Carter
Celanese Corp.

L. B. Steel
E. I. du Pont

E. L. Kropscott, Ass't. Mgr.
Plastic Technical Service
Dow Chemical Co.

Lloyd Stouffer, Editor
Breskin Publications

Egmond Arens
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Also speakers from Bakelite Co., to be announced.

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Cleveland-Akron

More Than 100 Hear Analysis Of 'Super' Polyethylene's Values

R. M. Hershey

More than 100 members and guests including several National SPE representatives and councilmen attended the September 12 dinner meeting of the Cleveland-Akron Section held at the Spanish Tavern in Brecksville, Ohio.

The meeting featured a discussion of Super Dylan polyethylene by Mr. George Sollenberger, Technical Coordinator of Plastic Market Development for the Koppers Company.

Super Dylan is the Koppers Company's trade name for their new high molecular weight, high temperature resistant polyethylene manufactured by license using the Ziegler process. Super Dylan and the other new polyethylenes manufactured under the Ziegler or Phillips Petroleum licenses have become known as "low-pressure," "high-modulus," "high-temperature," and "high-tensile" polyethylenes.

Mr. Sollenberger stated that the development of the new high-tensile, high-temperature polyethylene makes available a completely new material for plastic fabricators. The new material has high rigidity, good temperature resistance, high impact strength, and good chemical resistance.

Mr. Sollenberger predicted that many new applications would be made possible using the properties of the new polyethylene. He felt that the new material would find its greatest outlet in new applications rather than in the replacement of older plastic materials.

No Miracle Material

The importance of plastic processors becoming familiar with the limitations as well as the advantages of the new material was stressed. Mr. Sollenberger cautioned against a tendency to regard the new polyethylene as a miracle material.

The new polyethylene has a smooth and hard surface finish which is not waxy in appearance as conventional polyethylene. As with conventional polyethylene the new material is transparent in thin films and a translucent white in thicker sections. Consequently, almost any color is possible with the material.

The hardness of the new polyethylene is about 65 on the Shore D scale as compared to 45 for standard polyethylene. The specific gravity of the new polyethylene is about 0.94 as compared to 0.92 for standard polyethylene.

The new polyethylene couples an increased toughness with an increased rigidity. The tensile strength of the new polyethylene can be as high as 6500 psi, while the stiffness modulus can be as high as 150,000 psi. The increased toughness and rigidity will make possible tougher insulation on wire coatings, self-supporting structures, cups, and similar articles which must maintain their shape.

The bursting strength of pipe made using the new polyethylene is approximately three times as great as that of the same size pipe in conventional polyethylene and the improvement is maintained at moderately elevated temperatures. Long term life tests at various temperatures and pressures are now in progress.

The strength of Super Dylan monofilaments is approaching the strength of nylon monofilaments.

Chemical resistance of the new polyethylene is as good as that of conventional polyethylene.

Vapor transmission rates of the new polyethylene are about one-third that of conventional polyethylene. This improvement will be of particular importance in the packaging field.

Can Withstand 250°F.

The new polyethylene can withstand a continuous temperature of 250°F. without losing its shape. However, it should be noted that although items will not lose their shape at 250°F., the parts will have no strength at that temperature.

The new polyethylene is considerably tougher at low temperatures than conventional polyethylene. The strength of the material drops very little at −100°F. This property will open up many new applications in military, aircraft, and refrigeration fields.

Irradiation of the new polyethylene produces still better properties in the material. New vacuum forming applications may be possible with the irradiated material.

The much lower plant investment required for the new polyethylene as compared to conventional polyethylene should eventually result in a much lower price, and a price of 30c per pound may be possible.

Tumblers molded from Super Dylan were distributed to the audience by Mr. Sollenberger. A question and answer period followed this meeting with the program chairman, Mr. Ren Morse, Injection Molders Supply Company, acting as moderator.

Mr. Underwood Speaks

Prior to the technical session the Section President, Mr. Sherman Crawford of DME Corporation, introduced Mr. P. James Underwood, Executive Secretary of the SPE. Mr. Underwood addressed the Section briefly and complimented the Section and the 1956 Technical Conference Chairman, Mr. F. A. Martin of the Hoover Company, on the progress of the coming Conference.

The SPE National President, Mr. F. W. Reinhart of the National Bureau of Standards, introduced Dr. Jesse H. Day, Editor of the SPE Journal, and several National Councilmen who were present at the meeting. The National Councilmen present were:

H. S. Nathan, Atlas Prod., Buffalo Section; J. T. Bent, Eastman Chemical Prod., Chicago Section; D. F. Hoffman, Evans-Winter-Hebb, Detroit Section; F. C. Sutro, Spencer Chemical, Kansas City Section; P. W. Simmons, Newark Section; D. D. James, Central Indiana Section; W. I. Pribble, Pribble Plastics Prod., Northern Indiana Section; J. L. Formo, Minneapolis-Honeywell Reg., Upper Midwest Sect.; J. R. Davidson, Kentuckiana Section.

Mr. Granville Shirley, Colonial Plastics Mfg. Co., introduced the following fourteen guests who were present at the meeting:

W. Mertz, Dobeckmun Company; J. Moss, Dobeckmun Company; J. Gazdik, Akro Mold, R. King, Heil Process Equipment Corp.; D. E. Holmgren, Heil Process Equipment Corp.; F. Boston, Pyramid Rubber; H. Frolich, Harcour Mfg.; E. Linsky, B. F. Goodrich; A. J. Sopko, Packard Electric; R. K. Senn, National Rubber Machinery; F. E. Smet, National Rubber Machinery; J. R. Heiser, National Rubber Machinery; J. Magie, Ferrel-Birmingham; P. Calby, Bakelite Co.

Welcomes 26 New Members

The Section Secretary, Mr. H. Oliver of Eastman Chemical Products Inc., welcomed the following 26 new members and transfer members who were added to the Section since last spring:

Carl Virgin, Spencer Chemical Co., Chicago Section; Joseph Herbert, Bakelite Co., Philadelphia Section; Richard Derr; Argus Chemical Corp., Philadelphia Section; Walter Meyer, Logo, Inc., Detroit Section; Arnold Schwartz, National Plastics and Chem. Corp; Stanley Lesper, Structural Fibers, Inc.; Jerome Szpila, National Plastics & Chem. Corp.; Paul Earley, General Tire & Rubber Co.; John Slabaugh, R. H. Freitag Mfg. Co.; Leonard Kirtz, National Plastics & Chem. Corp.; Arthur Anzalone, Cleveland Plastics, Inc.; Robert Brumbach, Samuel Moore and Co.; James Jenkins, Diamond Alkali; George Tow, West Instrument Corp.; N. W. Bass, Brush Beryllium Co.; Armand Beaudoin, Ferro Corporation; Justin Cantor, Wheelco Instruments Div.; William McBrien, Diamond Alkali Co.; Bruno Zane, The Hoover Co.; Rocky Mittiga, Gor Mold & Machinery Co.; George Gmitter, General Tire & Rubber Co.; F. Edward Smith, Prosper Mold & Die; Don Trump, Trump Plastics; Lester Giga, Wooster Rubber; Milan Krajcik, Wooster Rubber; John Phipps, Conneaut Rubber & Plastics Co.

(Continued from page 32)

THE IMPORTANCE OF ORDER IN THE MOLECULAR STRUCTURE OF VINYL POLYMERS:
P. Platziek, PP. 420-423

The properties of a linear polymer are determined by its structural formula, its molecular weight and to a great extent by its degree of branching. In the case of polyethylene, long side chains are formed by chain transfer from a growing macromolecule to another molecule (polymer or monomer).

Short side chains in the polyethylene, it is believed occur due to intramolecular chain transfer.

In the polymerization of dienes, each 1, 2-addition causes branching. A good example of the effect of branching on properties is starch. Amylose, a linear polymer is not water soluble (pH8) whereas amylopectine, a branched polymer is readily soluble in cold water. Ziegler's low pressure polyethylene is discussed. All indications are that high temperature and pressure, in the polymerization of ethylene, cause branching. Natta's polystyrene consists of orderly, linear chains with a head to tail structure; the softening point reportedly is 230°C, or about 150°C higher than commercial polystyrene.

★

ITALY

POLIPLASTI

Vol. 3, No. 9, May, June, 1955

Abstracter: Alfred Alk

MACHINES FOR MANUFACTURING PVC. SECTION 3:
Giorgio Ughetto and Carlo Colombo

This is the third article in a series dealing with the manufacture of PVC products. The article is limited to a discussion of calandering and describes briefly the several types of roll configurations, giving for each either its historical place in calander development or its good and bad points in terms of production capabilities.

Production of sheets and of cloth laminates are discussed as are techniques for maintaining even temperatures across the faces of the various rolls. Considerable space is devoted to the evolution of driving mechanisms to emphasize the relationship between adequate drives and specifications for the product. The article is illustrated with drawings and photographs of modern machines.

A NEW TYPE OF EXPANDED POLYSTYRENE:
F. R. Stastny

Styropor was developed between 1949 and 1952 by Badische Anilin & Soda Fabrik A. G. It is furnished in the form of blocks (type B ME) or small irregular granules (type K) which may be inflated by raising the material temperature above 70-degrees C. Hot water, hot air and ordinary and super-heated steam can be used for heating. The product is a closed cell foam with Specific Gravity of from 0.02 to 0.5 depending upon choice of manufacturing conditions. Production methods are discussed and typical products are illustrated.

THE MILAN FAIR

Three articles are given over to the 33rd Annual Milan Fair. One of these is an 8-page picture story of the plastic booths at the fair showing both equipment and products of local industry.

THE BARI CONVENTION FOR PLASTIC PRODUCTION IN SOUTHERN ITALY:

Transcription of the afternoon session Sept. 14, 1954.

Sections covering: production news, reviews from the foreign press, book reviews, news about resins, economic news, society notes, and new process equipment.

Southern California

Hydraulics, Pneumatics Discussed At Meeting

Walter H. Kadlec

The first meeting of the Southern California Section in the Fall series was held at Scully's Restaurant in Los Angeles, September 1st.

Program Chairman William Dewar, feeling the need for basic knowledge within the membership, called upon sales representatives of the Haskell Engineering Company to discuss hydraulics and pneumatics in equipment used in processing plastics.

Mr. Ed Lauren opened his talk with a review of the symbols adopted by the Joint Industry Conference for schematic representation of hydraulic systems. Then using the symbols he outlined various pressure circuits in current use on molding presses and other liquid operated equipment. With particular attention to plastics processing, Mr. Lauren enlarged upon the use of valves in high-low pressure systems and the use of accumulators.

Mr. Robert Hamilton spoke briefly on pneumatics with reference to forming presses. Both speakers were joined by Mr. Dave Kinsey, chief project engineer for Haskell, in a lively question and answer session. The sustained interest was indicative of a good presentation.

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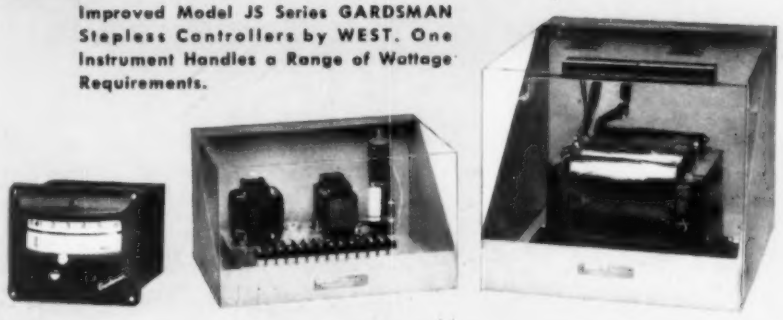

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Plastics In Electric Circuits

Richard G. Newhall

The Golden Gate Chapter of the Society of Plastics Engineers resumed its technical meetings after the summer recess with a discussion of "Plastics in Printed Electronic Circuits," presented by Charles Calvert of Q-Circuits Company, San Francisco. The speaker began by reviewing the principal types of base materials which are used for printed circuits. The most commonly used today are: Phenolic-paper base, Melamine-linen, Epoxy-fiberglas, Silicone-glass, Melamine-glass. The latter two are considered very difficult to work with, since they are extremely hard and carbide tooling must be used.

The manufacture of a printed circuit base starts with a semi-cured laminate to which an adhesive is added. A thin sheet of copper—generally 0.001" thick—is then carefully rolled on and the assembly is placed in a laminating press for cure. The sheet copper used for this purpose is electrodeposited on rotating polished stainless steel drums to give a film with the necessary uniform thickness and high purity.

The printed circuit fabricator starts by making a very accurate drawing of the finished circuit—usually two to four times the finished size. This is then reduced to the desired dimensions and a resist is applied to the base material by photoengraving, silk screening or offset printing. Photoengraving is the most accurate of these methods according to the speaker, and in exceptional cases patterns have been applied to the copper with an accuracy of ±0.0005". A more typical figure, however, would be ±0.002" or +0.003" with no minus tolerance.

After the resist has been applied, the copper is etched in 42° Be: ferric chloride. A fresh etching solution will require about three minutes to etch 0.001" copper, but this time will increase as the solution ages. When the etching time reaches about 15 minutes, the solution is discarded.

The completed circuit may be protected by coating with one of several commercially available finishes which will protect both the copper and the plastic laminate. In those cases where wear on the copper is a factor, the circuit may be rhodium plated. The speaker exhibited a circular copper ring which has been plated with 0.0000005" of rhodium, and which showed no visible wear after 250,000 revolutions of a contact arm.

The circuit may be cut to size and shape either with a metal cutting table saw or by punching. In the latter case high speed toll steel dies are recommended, and the die and stripper plate should fit very closely so as to prevent lifting the copper. Warming the laminate before punching is also advisable.

Southern

Panel On Vacuum Work

C. Veazey LeCraw

The Southern Section got together for its first meeting of the fall on September 19, at Mammy's Shanty in Atlanta. After suspending meetings for the summer months, the section had a fine turn out of some 40 members and guests to hear a panel of speakers elaborate on the various tooling, materials, and techniques required in the relatively new and fast growing field of vacuum forming.

First on the program was a talk on the techniques of turning out accurate and long lasting tools made from Gypsum plastics. The talk was presented by Mr. C. D. Quarles, Jr., and afterwards a filmstrip on the same subject was presented by Mr. K. L. Michel, both of the U. S. Gypsum Company. A discussion on materials followed which included talks by Mr. Joseph B. Schmidt, Koppers Company, Mr. Joseph H. Jones, Bakelite Company, and Mr. W. H. Kuhlen, Marbon Chemicals. They presented the pros and cons of various vacuum formable materials such as high impact styrene, vinyls, polyethylene, acetates, and acrylics. It was pointed out that only 2 million pounds of materials were used for vacuum forming in 1950 whereas a 1955 estimate is set at 50 million pounds, and it is predicted that 200 million pounds of plastics will be vacuum formed in 1960.

The Section wishes to take this opportunity to wish Leo Diamond of Koppers Company, our very capable president this year, the best of everything in his new assignment in Chicago. He leaves with the sincere thanks of everyone for the effort he has expended in making 1955 an interesting and productive year for the Southern Section. Vice President Clarence E. Ballentine, of Scripto, Inc., will serve as president for the remainder of the year.

A report from our Educational Committee, headed by Clarence Ballentine, gave plans for conducting a survey of fourteen technical colleges in the Southeast to determine how much technical literature on plastics is available to the students in the libraries of these schools. It is planned that the Southern Section will donate subsubscriptions of the SPE Journal to the libraries of all of these institutions.

Baltimore-Washington

Western Electric Plant Visited

William C. Rainer

The October 11th meeting featured a tour of the Western Electric Company's Point Breeze Plant in Baltimore, Maryland. The total attendance numbered 106. Section President, Dan Nitzberg, called the meeting to order at 8 P.M. in the plant cafeteria. After a brief business session, the meeting was turned over to M. C. Bert Rutherford of W. E. who gave a short word-preview of operations on parade. John Woodland described polyester applications in the plant. In conclusion, Jim Becker arranged the group into smaller units with guides for the tour.

The group's first introduction to the plant was an exhibition of modern big business in full automation. They saw the stepwise integration of a PVC extrusion compound. Sundry raw materials were metered out automatically to a traveling belt feeding a continuous mixer. Without interruption in flow, the blend was piped to the supply manifold feeding several extruders. Here the PVC was cross extruded onto copper wire at a rate in excess of 1800 feet per minute. A similar extrusion process was also observed with polyethylene.

The group also witnessed the technique of handling polyesters en masse. Stub cables, binding posts and terminals were assembled into plastic shells, filled with casting resin and cured in situ.

Other operations of interest were: knitting of cotton barrier over conductors, spiral wrapping of flat bronze ribbon around cotton thread, stranding of wires to form telephone cables, extrusion of lead seamless jacket onto cable cores.

The tour was climaxed with refreshments in the plant cafeteria. Our thanks to Western Electric Company for courtesies extended.

NOTES OF INTEREST

Daniel I. Nitzberg, present president of Baltimore-Washington Section of SPE, has been operating his own business for the past several months, known as the Circuit Service of Baltimore. His business address is 3805 Fear Avenue, Baltimore, Maryland. Phone: Forest 7-6814. His business specializes in printed circuits for the Baltimore-Washington area.

ONE GRAND

Yes, The S.P.E. Is Setting Its Sights On 1,000 NEW MEMBERS By January 16!

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PLASTIC SALES ENGINEER

We are seeking a well qualified man experienced in plastics extrusion for attractive Market Development position. Kindly give your education, experience, and expected salary in complete resume. All replies will receive careful attention and will be held confidential. Write: 108 Personnel Department, Chemical Division, Koppers Company, Pittsburgh 19, Pa.

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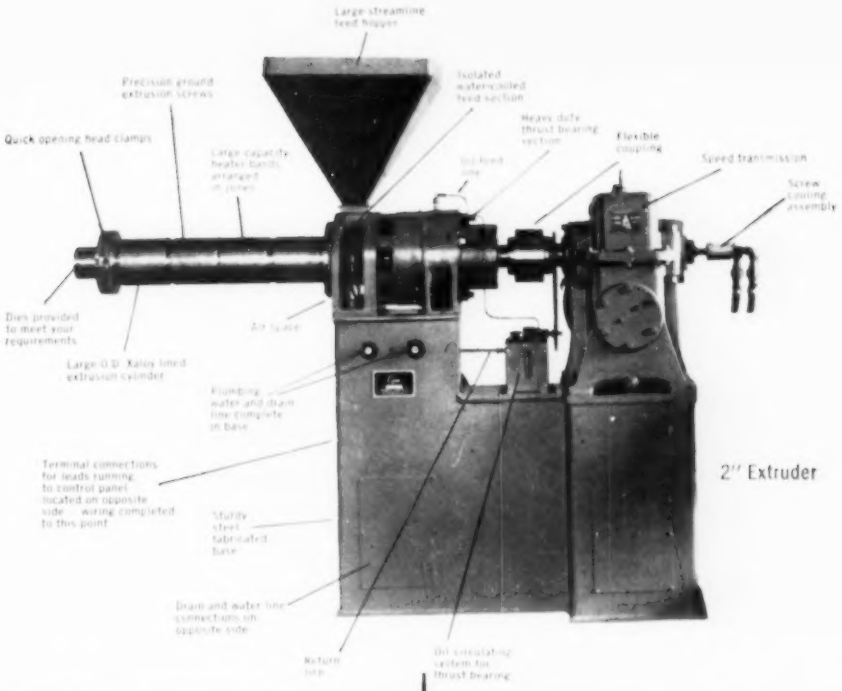
Egan plastic extruder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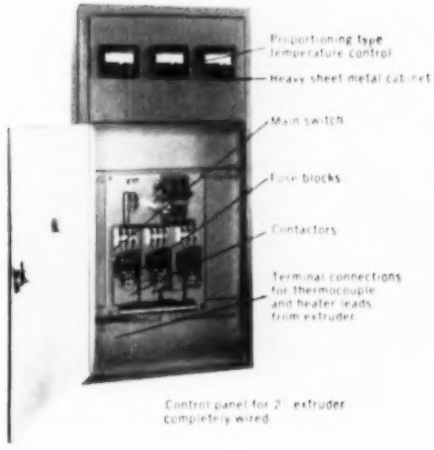

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